II. SPECIES ACCOUNTS

A. California Jewelflower (Caulanthus californicus)

1. Description and Taxonomy

Taxonomy.—The appropriate genus for California jewelflower has been debated (Payson 1923, Rollins 1971, Al-Shehbaz 1973), but it has been recognized consistently as a distinct species. Watson (1880) originally named the genus Stanfordia solely to accommodate this species. The type specimen (i.e., the individual plant on which the original description was based) of Stanfordia californica was collected "near Tulare" in Tulare County. Greene then transferred the species to Streptanthus in 1891 (Green 1891 as cited in Taylor and Davilla in litt. 1986). The currently accepted scientific name for California jewelflower, Caulanthus californicus, was published by Payson (1923). California jewelflower is a member of the mustard family (Brassicaceae).

Description.—California jewelflower has hairless, usually branching stems, which can range from less than 10 centimeters (4 inches) to more than 50 centimeters (20 inches) tall (Munz and Keck 1959, Mazer and Hendrickson in litt. 1993a, Cypher in litt. 1994a). The upper leaves are egg- shaped and clasp the stem, unlike the leaves at the base of the plant, which are oblong. The maroon buds are clustered at the tip of the stem and contrast with the translucent, white flowers below. The fruits of California jewelflower are 1 to 6 centimeters (0.4 to 2.4 inches) long, and flattened (Buck 1993).

Identification.—California jewelflower (Figure 5) differs from all other species of *Caulanthus* in that it has flattened, sword-shaped fruits and spherical seeds. Other jewelflowers also have maroon buds and whitish flowers, but those that overlap in range with California jewelflower have narrow, elongated fruits and flattened seeds (Buck 1993).

2. Historical and Current Distribution

Historical Distribution.—The historical distribution of California jewelflower is known from 40 herbarium specimens, which were collected in 7 counties between 1880 and 1973. Approximately half of the collection sites were on the floor of the San Joaquin Valley in Fresno, Kern, and Tulare Counties (Figure 6). Several

other collections came from two smaller valleys southwest of the San Joaquin Valley: the Carrizo Plain (San Luis Obispo County) and the Cuyama Valley (Santa Barbara and Ventura Counties). Three *occurrences* (i.e., collection sites separated by 0.4 kilometer [0.25 mile] or more) were in the Sierra Nevada foothills at the eastern margin of the San Joaquin Valley in Kern County. The remainder of the historical sites were in foothills west of the San Joaquin Valley, in Fresno, Kern, and Kings Counties (CDFG 1995, Taylor and Davilla in litt. 1986).

Current Distribution.—By 1986, all the occurrences on the San Joaquin and Cuyama Valley floors had been eliminated, and the only natural population known to be extant (i.e., still in existence) was in Santa Barbara Canyon, which is adjacent to the Cuyama Valley in Santa Barbara County (Taylor and Davilla in litt. 1986). A small, introduced colony also existed at the Paine Preserve in Kern County at that time. Since then, several more introductions have been attempted (see Conservation Efforts), and a number of colonies were rediscovered in two other areas where the species had been collected historically. The naturally-occurring populations of California jewelflower that are known to be extant today are in three centers of concentration: (1) Santa Barbara Canyon, (2) the Carrizo Plain in San Luis Obispo County, and (3) the Kreyenhagen Hills in Fresno County (CDFG 1995, Danielsen et al. in litt. 1994, B. Delgado pers. comm., R. Lewis pers. comm.).

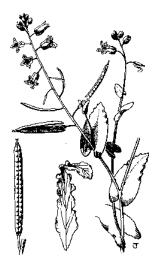


Figure 5. Illustration of California jewelflower (from Abrams 1944, with permission).

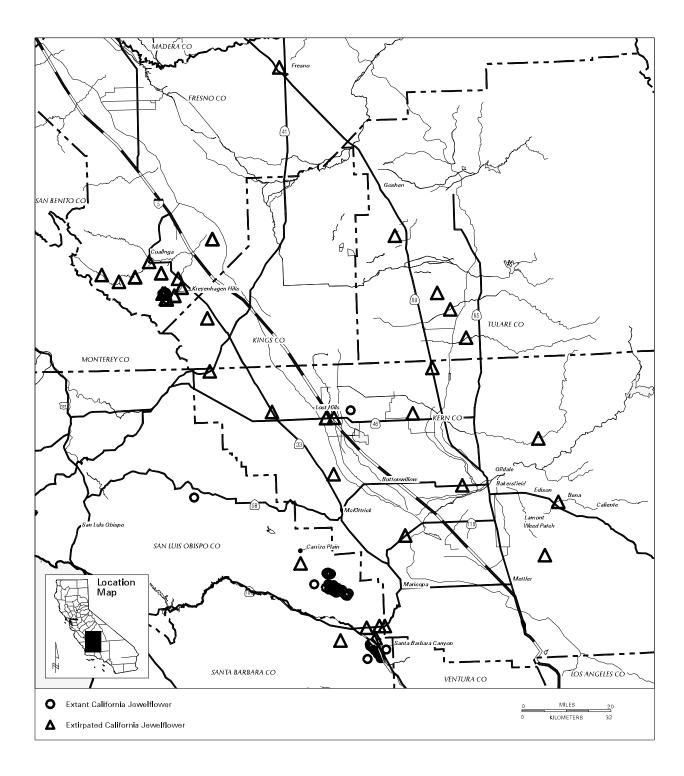


Figure 6. Distribution of California jewelflower (Caulanthus californicus).

The Santa Barbara Canyon *metapopulation* (i.e., scattered groups of plants that may function as a single population due to occasional interbreeding) occurs in an area of approximately 10 by 1 kilometer (6.5 by 0.5 mile) on the terraces just west of the Cuyama River and includes approximately 12 hectares (30 acres) of occupied habitat. The Carrizo Plain metapopulation is confined to the western side of the Carrizo Plain in a roughly triangular area measuring approximately 15 by 13 by 10 kilometers (9 by 8 by 6 miles) and encompassing approximately 4 hectares (10 acres) of occupied habitat (R. Lewis pers. comm.). The Kreyenhagen Hills metapopulation includes 4 small colonies within a 3 by 1 kilometer (2 by 0.5 mile) area of rolling hills (U.S. Bureau of Land Management [USBLM] in litt. 1994).

Additional populations of California jewelflower may persist in the foothills of Fresno, Kern, and Kings Counties, where potential habitat remains in rangeland. However, access to historical sites in these areas has been restricted, so the presence of the species has not been verified in over 50 years (CDFG 1995, Taylor and Davilla in litt. 1986).

3. Life History and Habitat

California jewelflower is an annual, meaning that each plant lives less than one year, and the entire life cycle from seed germination to seed set is completed in a single growing season. As is typical of annuals, both plant size and population size in California jewelflower can vary dramatically, depending on site and weather conditions (Taylor and Davilla in litt. 1986, Mazer and Hendrickson in litt. 1993*a*, Cypher in litt. 1994*a*).

Reproduction and Demography (the study of population vital statistics, size and density, and distribution).—Seeds of California jewelflower begin to germinate in the fall when the rainy season begins, but additional seedlings may continue to emerge for several months. California jewelflower seedlings develop into rosettes (clusters of leaves at ground level) during the winter months, and the stem elongates as flower buds begin to appear in February or March. Flowering and seed set continue until the plants die, which may occur as late as May in years of favorable rainfall and temperatures. Seed-dispersal agents are not known, but those that have been suggested for California jewelflower and related genera include gravity, seedeating animals (Cypher in litt. 1994a), wind, and water (Al-Shehbaz 1973).

California jewelflower probably forms a persistent seed bank. In greenhouse trials, viable seeds did not germinate even when exposed to a variety of typical temperature and moisture conditions (Taylor and Davilla in litt. 1986). Only conditions simulating prolonged weathering induced seed germination (Mazer and Hendrickson in litt. 1993a). A persistent seed bank ensures that some seeds will be available to produce plants in succeeding years, even if no individuals survive to set seed in one unfavorable growing season (Philippi 1993). The presence of a seed bank would explain the reappearance of California jewelflower in uncultivated areas where it had not been observed for decades.

Pollinator-exclusion experiments indicated that insects are necessary for seed set in California jewelflower (Mazer and Hendrickson in litt. 1993a). Honeybees (*Apis mellifera*) have been observed visiting the flowers (R. Lewis pers. comm.), but native insects also would be expected to serve as pollinators. Closely-related species of the genus *Thelypodium* were visited by several species of bees (*Bombus* sp., *Apis* sp., and *Xylocopa* sp.) and butterflies (*Pieris* sp.) (Al-Shehbaz 1973). Both cross- and self-pollination resulted in seed set in greenhouse trials (Mazer and Hendrickson in litt. 1993a).

In 1992 and 1993, which were years of above-average rainfall during the growing season, 46 percent to 85 percent of plants in study areas on the Carrizo Plain survived long enough to produce seed (Mazer and Hendrickson in litt. 1993a, Cypher in litt. 1994a). However, in years of below-average precipitation or above-average temperatures, all the plants may die before setting seed (R. van de Hoek pers. comm.). Seed production in California jewelflower may vary greatly among individuals, sites, and years. In 1992, average seed production per plant was 711 on the Carrizo Plain and 278 in Santa Barbara Canyon (Mazer and Hendrickson in litt. 1993a). In 1993, the estimated number of seeds per plant on the Carrizo Plain ranged from 4 to over 11,000 and averaged 929, compared to 49 in the Kreyenhagen Hills (E. Cypher unpubl. data).

Habitat and Community Associations.—Extant populations of California jewelflower occur in Nonnative Grassland, Upper Sonoran Subshrub Scrub, and Cismontane Juniper Woodland and Scrub (E. Cypher unpubl. data). Historical records suggest that California jewelflower also occurred in the Valley Saltbush Scrub community in the past (CDFG 1995).

Herbaceous cover was dense at most California jewelflower sites studied in 1993 (Cypher in litt. 1994a). Native plant species, such as annual fescue (Vulpia microstachys), clovers (Trifolium spp.), red maids (Calandrinia ciliata), and goldfields (Lasthenia californica) comprised a high proportion of the vegetation at many of the known locations over several years. The exotic grass red brome (Bromus madritensis ssp. rubens) was a significant component of the vegetation only at the Carrizo Plain sites (Taylor and Davilla in litt. 1986, Lewis in litt. 1993a, Cypher in litt. 1994a, E. Cypher unpubl. data). On the Carrizo Plain, California jewelflower occurred primarily on the burrow systems of giant kangaroo rats (Dipodomys ingens), another endangered species (Cypher in litt. 1994a).

Populations of California jewelflower have been reported from elevations of approximately 75 to 900 meters (240 to 2,950 feet) and from level terrain to 25 percent slopes. Soils at known sites are primarily subalkaline, sandy loams (CDFG 1995, Taylor and Davilla in litt. 1986, Lewis in litt. 1993a).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—The primary reason for the decline of California jewelflower was habitat destruction. All the populations on the San Joaquin and Cuyama Valley floors have been eliminated. Conversion to agriculture accounted for the loss of most sites, but those closest to Bakersfield and Fresno were destroyed by urbanization. Oilfield activity may have eliminated a few sites in the foothills at the western margin of the San Joaquin Valley (Taylor and Davilla in litt. 1986).

Threats to Survival.—Development remains a threat in Santa Barbara Canyon, where more than 90 percent of the California jewelflower metapopulation occurs on private land. The California jewelflower habitat near the canyon mouth is for sale; the landowner cleared California junipers (Juniperus californica) from the site and planted ornamentals in anticipation of residential development (Lewis in litt. 1993a). California jewelflower on private land in the upper portion of Santa Barbara Canyon is subject to cattle grazing throughout the growing season, but the magnitude of threat posed by livestock is unknown. Grazing in the period between the rosette stage and seed set is believed to be detrimental to California jewelflower because seed set would be reduced if flowering or fruiting stems were consumed (Mazer and Hendrickson in litt. 1993a, R. Lewis pers. comm.).

Potential threats to one or more of the remaining populations of California jewelflower include competition from exotic plants, pesticide effects on pollinators, and small population size. In a preliminary study, seedling mortality was higher in plots that contained dense vegetation than in plots where all plants but California jewelflower had been removed (Mazer and Hendrickson in litt. 1993a). Red brome could be particularly competitive because some strains are resistant to air pollution (Westmann et al. 1985 in Taylor and Davilla in litt. 1986). Insecticides could present a threat to California jewelflower viability on the Carrizo Plain by decreasing pollinator populations. The California Department of Food and Agriculture sponsors a widespread malathion-spraying program on natural lands in the southern San Joaquin Valley and Carrizo Plain to control the insect vector of the curly-top virus, which affects many crop plants. Spraying is allowed at the discretion of California Department of Food and Agriculture (Clark in litt. 1991). The effect of malathion on native insect populations has not been investigated. Small population size may be another factor in the continued existence of California jewelflower. The Kreyenhagen Hills metapopulation dropped to only 62 in 1992 (USBLM in litt. 1994).

5. Conservation Efforts

California jewelflower was state listed as endangered in 1987 and federally listed as endangered in 1990 (USFWS 1990; Table 1). Intensive and extensive survey efforts were undertaken by biologists from the California Energy Commission, USBLM, and U.S. Forest Service, beginning in 1987. Their efforts led to the discovery of many new occurrences and the rediscovery of several that were thought to have been eliminated. Surveys for additional populations are continuing in suitable habitats on the Los Padres National Forest and USBLM lands in the Bakersfield District (Danielsen et al. in litt. 1994, B. Delgado pers. comm., R. Lewis pers. comm.).

The known California jewelflower habitat in two of the three concentration areas is in public ownership. The Carrizo Plain metapopulation is entirely within the Carrizo Plain Natural Area, which is administered jointly by USBLM, The Nature Conservancy, and CDFG. USBLM also administers the Kreyenhagen Hills and a small part of Santa Barbara Canyon. Populations in each of these areas have been monitored annually by USBLM personnel since 1991. USBLM no longer allows greenseason grazing in California jewelflower habitats under

its management, which include approximately 40 percent of individuals known to be extant. In 1994, an exclosure was constructed around the plants on public land in Santa Barbara Canyon to prevent trespass grazing (R. Lewis pers. comm.).

Several experimental introductions of California jewelflower have been attempted in Kern, Santa Barbara, and Tulare Counties on lands protected by The Nature Conservancy and the Los Padres National Forest (Taylor 1988, CDFG 1995). In all instances, the number of plants at each site has declined precipitously following the initial seeding (Taylor and Davilla in litt. 1986, Danielsen et al. in litt. 1994). Possible causes of failure included unfavorable site conditions, use of seed sources that were not adapted to the introduction site, lack of genetic diversity in the introduced populations, and insufficient numbers of seeds (Taylor and Davilla in litt. 1986, Mazer and Hendrickson in litt. 1993a, Danielsen et al. in litt. 1994). Considering the variable germination rates in natural populations, plants may reappear at some of the reintroduction sites after several years. Future reintroduction efforts can build on the experience gained from these early trials.

Preliminary research on the reproductive biology, demography, and ecology of California jewelflower has been conducted by Dr. Susan Mazer and associates from the University of California, Santa Barbara, and by Dr. Ellen Cypher and associates from the Endangered Species Recovery Program. Funding for these studies was provided by CDFG, the National Science Foundation, USBLM, and Endangered Species Recovery Program. The U.S. Natural Resources Conservation Service is considering artificial propagation of California jewelflower to aid research and restoration efforts (D. Dyer pers. comm.).

6. Recovery Strategy

Although restoration of California jewelflower to all its former sites of occurrence is not feasible, the recovery goal is to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the species and in a variety of appropriate natural communities. Surveys will be necessary to determine whether natural populations remain in all target areas. Where natural populations no longer exist, such as the floor of the San Joaquin Valley, reintroduction will be necessary to achieve recovery. However, reintroduction is expensive and experimental,

and thus the preferable course of action is to locate and protect the remaining occupied habitat wherever possible. Unoccupied habitat within *metapopulations* also should be protected to facilitate movement of pollinators and seed dispersers. Thus, additional elements of the strategy are to protect land in blocks of at least 65 hectares (160 acres) and to avoid fragmenting any metapopulation into more than 2 blocks of contiguous, protected natural land. Finally, buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion.

The top-priority action for recovery of California jewelflower is to protect the plants on private land in Santa Barbara Canyon. The site could be secured through fee title acquisition or conservation easements. Continued protection and appropriate management of all occupied habitat on public lands also is essential. A number of additional tasks are required to achieve These tasks include developing recovery goals. management plans, surveying for additional populations, banking seed, conducting research, and modeling population demographics using matrix projection Interim management plans should be modeling. developed for each protected area to ensure that recovery of California jewelflower and other listed species is the primary goal. Management plans may need to be revised if populations begin declining or research identifies limitations to population viability.

Surveys are particularly important in the foothills east of the San Joaquin Valley to determine if historical populations remain extant. If populations are rediscovered in that area their protection would be a highpriority task because they are likely to incorporate genotypes not found elsewhere in the range. Seeds should be collected from each of the known metapopulations and any occurrences discovered in the future, according to the guidelines established by the Center for Plant Conservation (1991). Seed collections should be used for two purposes: to conserve the genetic diversity of the species in seed-banking facilities; and to allow greenhouse propagation of the species, which would allow experimental introductions and manipulative studies without jeopardizing natural populations or continuing to deplete natural seed banks (Mazer and Hendrickson in litt. 1993a). Continued demographic research is necessary to determine which stages in the life cycle are limiting (Schemske et al. 1994). Limiting factors may vary among California jewelflower

populations and can include pollinator availability, competition from introduced plants, consumption by kangaroo rats or livestock, or physical site characteristics (Mazer and Hendrickson in litt. 1993a, Cypher in litt. 1994a). Annual monitoring also is necessary to indicate whether population levels are increasing, decreasing, or remaining stable (Cypher in litt. 1994a, Schemske et al. 1994).

B. PALMATE-BRACTED BIRD'S-BEAK (CORDYLANTHUS PALMATUS)

1. Description and Taxonomy

Taxonomy.—Palmate-bracted bird's-beak, a member of the snapdragon family (Scrophulariaceae), was first described as Adenostegia palmata (Ferris 1918). The type locality (i.e., the site from which the type specimen was collected) was "at Tule near College City, Colusa County" (Ferris 1918, p. 420). In a subsequent revision, Adenostegia was transferred to the genus Cordylanthus (Macbride 1919), resulting in the currently-accepted name Cordylanthus palmatus (Chuang and Heckard 1993). Plants from the southern portion of the range initially were considered by Pennell (1947) to be a different species, fleshy bird's-beak (Cordylanthus carnulosus). The type specimen of fleshy bird's-beak was collected 6 miles south of Kerman, in Fresno County (Chuang and Heckard 1973). Cordylanthus carnulosus later was reduced to a subspecies of C. palmatus (Munz 1958), and finally was merged completely with C. palmatus (Chuang and Heckard 1973).

Description.—Palmate-bracted bird's-beak (Figure 7) is a highly branched annual that can reach 30 centimeters (12 inches) in height. The glandular hairs are short (less than 1 millimeter; less than 0.04 inch) and excrete salt crystals, making mature plants appear grayish-green. In all Cordylanthus species, the corolla (the set of petals) is club-shaped and is divided lengthwise into two lips (groups of fused petals that differ in appearance). The upper lip is hooked like a bird's beak and the lower lip is inflated like a pouch. The flowers are nearly hidden by bracts, which are leaf-like structures. In palmate-bracted bird's-beak, the outer bracts are green; the inner bracts are lavender and deeply divided into finger-like segments (i.e., palmate). The corolla is hairy, whitish to lavender on the sides, and has fine purple stripes on the lower lip. The seeds have distinctive arching crests.

Identification.—Palmate-bracted bird's-beak differs from the closely-related hispid bird's-beak (*C. mollis* ssp. *hispidus*) in that the latter has bristly hairs longer than 1 millimeter (0.04 inch), whitish to yellowish flowers, and lacks crests on the seeds (Ferris 1918, Chuang and Heckard 1993). Fleshy bird's-beak is distinguished from palmate-bracted bird's-beak by its branching pattern and hair characteristics (Chuang and Heckard 1973).

2. Historical and Current Distribution

Historical Distribution.—Nine natural populations of palmate-bracted bird's-beak were documented between 1916 and 1982, but only two were known to be extant as of 1985 (USFWS 1986). The historical occurrences were in the following vicinities: College City; Livermore (Alameda County); Alkali Sink Ecological Reserve, Kerman, and two near Mendota (Fresno County); between Firebaugh and Madera (Madera County); Stockton (San Joaquin County); and Woodland (Yolo County) (Chuang and Heckard 1973, CDFG 1995, Heckard in litt. 1977). Hoover (1937) indicated that palmate-bracted bird's-beak grew near Bakersfield, but that locality has not been substantiated.

Current Distribution.—As a result of intensive survey efforts and additional introductions, palmatebracted bird's-beak now is known to occur in seven metapopulations: four in the Sacramento Valley, one in

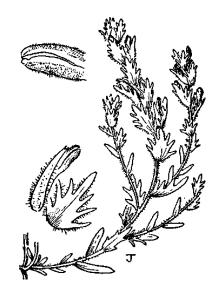


Figure 7. Illustration of palmate-bracted bird's-beak (from Abrams 1951, with permission).

the Livermore Valley, and two in the San Joaquin Valley (Figure 8). In approximate order from north to south, these metapopulations are (1) Sacramento National Wildlife Refuge in Glenn County, (2) Delevan National Wildlife Refuge in Colusa County, (3) Colusa National Wildlife Refuge in Colusa County, (4) the Woodland area, (5) Springtown Alkali Sink near Livermore, (6) western Madera County, and (7) the combined Alkali Sink Ecological Reserve and Mendota Wildlife Management Area. The total occupied surface area over the seven metapopulations is estimated at less than 300 hectares (741 acres). The Delevan National Wildlife Refuge and Colusa National Wildlife Refuge metapopulations account for approximately 80 percent of the total number of individuals, and the Springtown Alkali Sink metapopulation accounts for another 19 percent (Center for Conservation Biology 1994, CDFG 1995).

3. Life History and Habitat

Cordylanthus species are hemiparasitic annuals, meaning that they manufacture their own food but obtain water and nutrients from the roots of other plants (i.e., host plants; Chuang and Heckard 1971). Saltgrass (Distichlis spicata) is the most likely host plant for palmate-bracted bird's-beak. The combination of hemiparasitism, salt excretion, and a deep root system allows palmate-bracted bird's-beak to grow during the hot, dry months after most other annuals have died (Coats et al. 1993).

Reproduction and Demography.—This species flowers from May until October (Skinner and Pavlik 1994). Bumblebees (Bombus californicus, B. occidentalis, and B. vosnesenskii) were the primary pollinators of palmate-bracted bird's-beak at the Springtown Alkali Sink in 1993. The bees nested in uplands more than 100 meters (328 feet) distant from the population, and each bee visited only one group of palmate-bracted bird'sbeak plants (Center for Conservation Biology 1994). Both self- and cross-pollination can contribute to seed-set (Center for Conservation Biology 1993), and individual plants can produce up to 1,000 seeds in a single growing season (Center for Conservation Biology 1991). Despite the formation of a persistent seedbank, the number of plants in a population varies yearly in response to environmental conditions, particularly precipitation (Center for Conservation Biology 1994). Seasonal overland flooding may disperse seeds and promote seed germination by diluting the saline soils (Coats et al.

1993); in laboratory tests, seed germination rates were significantly higher in low-salinity than in high-salinity solutions, regardless of alkalinity (Center for Conservation Biology 1991). However, prolonged flooding would not be conducive to survival of palmate-bracted bird's-beak (A. Howald pers. comm.).

Genetic studies of the Colusa, Delevan, Springtown, and Alkali Sink Ecological Reserve/Mendota National Wildlife Refuge populations indicated that the Springtown metapopulation incorporated almost all the genetic variability known in the species. The Alkali Sink Ecological Reserve population contributed some additional genetic variation, but the Colusa and Delevan National Wildlife Refuge metapopulations did not. Thus, protection of the Springtown and Alkali Sink Ecological Reserve metapopulations was considered to be crucial to recovery (Center for Conservation Biology 1994). Samples from Sacramento National Wildlife Refuge, Woodland, and Madera County were not evaluated.

Habitat and Community Associations.—This species is restricted to seasonally-flooded, saline-alkali soils in lowland plains and basins at elevations of less than 155 meters (500 feet). Within these areas, palmate-bracted bird's-beak grows primarily along the edges of channels and drainages, with a few individuals scattered in seasonally-wet depressions, alkali scalds (barren areas with a surface crust of salts), and grassy areas. Palmatebracted bird's-beak occurs in the Valley Sink Scrub and Alkali Meadow natural communities in association with other halophytes such as iodine bush (Allenrolfea occidentalis), alkali heath (Frankenia salina), glasswort (Salicornia subterminalis), seepweed (Suaeda moquinii), and salt grass (Holland 1986, Coats et al. 1993, CDFG 1995, Bittman in litt. 1985, 1986a). At Springtown Alkali Sink, palmate-bracted bird's-beak and hispid bird's-beak occur together (Center for Conservation Biology 1994). Suitability of microhabitats for palmatebracted bird's-beak depends primarily on soil pH and to a lesser extent on soil layering, salinity, and moisture. This species occurs on neutral to alkaline soils (pH 7.2 to 9.5) under natural conditions but has been grown on acidic soils in greenhouse trials (Coats et al. 1993, Center for Conservation Biology 1993, 1994).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Agricultural conversion eliminated the formerly-known palmate-bracted bird's-

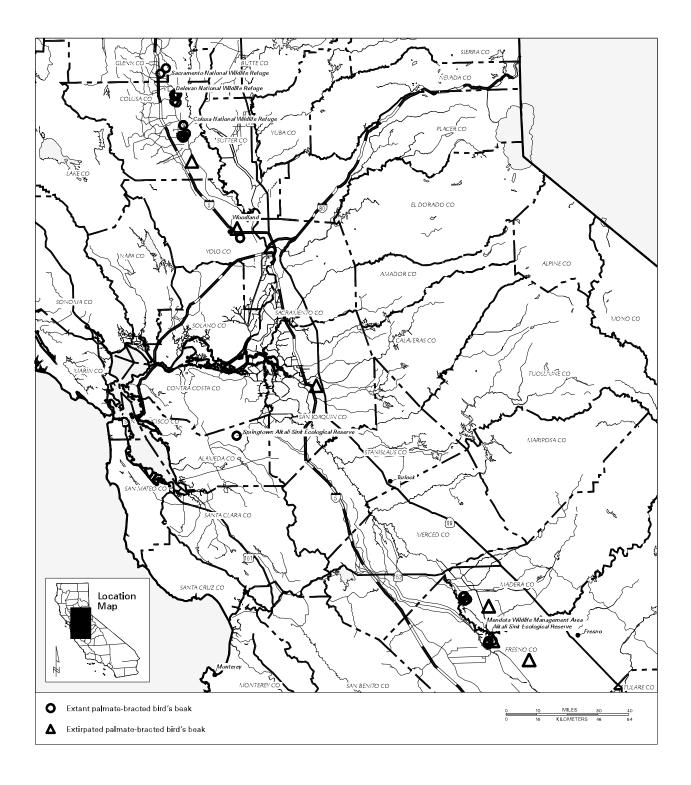


Figure 8. Distribution of palmate-bracted bird's-beak (Cordylanthus palmatus).

beak populations near College City, Kerman, and southeast of Mendota; reduced the size of the Woodland population; and destroyed extensive areas of potential habitat in the Sacramento and San Joaquin Valleys. Urban development was responsible for the destruction of the Stockton occurrence.

Threats to Survival.—Urban expansion (including commercial uses, residential development, and construction of recreational facilities) poses imminent threats at the Springtown and Woodland sites. Numerous other factors threaten the remaining populations. Changes in the hydrologic regime (seasonal water cycles and movements) by drainage, diking, and channelization have interrupted the seasonal overland flows and altered water salinity at Springtown, Woodland, and on lands adjacent to the Alkali Sink Ecological Reserve and National Wildlife Refuges. Because of the lack of genetic variability within and among the Sacramento Valley populations and the limited number of individuals in the Alkali Sink Ecological Reserve, western Madera County, and Woodland populations, random or catastrophic events could result in elimination of the species at any of these sites. Road maintenance is a potential threat at the Alkali Sink Ecological Reserve. The Springtown metapopulation faces many additional threats, including unauthorized fill of wetlands, encroachment by exotic plant species, off-road vehicle use, livestock wallowing in seasonal pools, and pesticide drift (Coats et al. 1993, Center for Conservation Biology 1994, CDFG 1995, A. Howald pers. comm.).

5. Conservation Efforts

The state of California listed palmate-bracted bird'sbeak as an endangered species in 1984, and USFWS did likewise in 1986 (USFWS 1986). In 1988, CDFG funded a project to map suitable habitats from aerial photographs and soil survey data (A. Howald pers. comm.). Since then, CDFG has sponsored intensive research on the biology, ecology, and management of palmate-bracted bird's-beak at the Springtown Alkali Sink. The first study focused on habitat characterization and resulted in development of a management plan for the area (Coats et al. 1993). The next series of investigations into the life history, reproductive biology, genetic composition, and site relationships were conducted by Center for Conservation Biology and resulted in the development of a long-term monitoring program for the Springtown Alkali Sink (Center for Conservation Biology 1994). Part of the Springtown Alkali Sink has been proposed as

a mitigation banking area for surrounding development; under the proposed plan, restoration and management also would be undertaken (Coats et al. 1993). However, the mitigation bank would protect at most 25 percent of the occupied habitat, it is a commercial enterprise that will continue only as long as it is profitable, and restoration may not begin for many years (A. Howald pers. comm.).

Personnel at the Sacramento National Wildlife Refuge complex have contributed to conservation of palmate-bracted bird's-beak in several ways. In 1990, National Wildlife Refuge biologists established a new population at Sacramento National Wildlife Refuge by scattering seeds that had been collected from Delevan National Wildlife Refuge. The National Wildlife Refuge complex avoids inundating known occurrences of palmate-bracted bird's-beak, and the hydrology and vegetation in occupied habitat are being restored to historical conditions. Refuge staff also monitor known populations on the Sacramento National Wildlife Refuge complex annually and consider the species when any management activities are proposed or planned in occupied habitat (G. Mensik pers. comm.). At least one group of plants has been fenced to restrict vehicle access and reduce the potential for trampling by waterfowl hunters (M.A. Showers pers. observ.).

Additional conservation efforts have included surveys and another reintroduction. The palmate-bracted bird's-beak population on private land in western Madera County was discovered in 1993 during surveys by the Endangered Species Recovery Program. A small transplant colony was established at the Mendota Wildlife Management Area in 1973 using seed collected from a nearby population that was about to be eliminated (CDFG 1995, Heckard in litt. 1977).

6. Recovery Strategy

The recovery goal for palmate-bracted bird's-beak is to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the species and in a variety of appropriate natural communities. Surveys will be necessary to determine whether natural populations remain in all target areas; if natural populations are not found, reintroduction will be necessary to achieve recovery. However, reintroduction is expensive and experimental, and thus the preferable course of action is to locate and protect the remaining occupied habitat wherever possible. Unoccupied habitat

within metapopulations also should be protected to facilitate seed dispersal and pollinator movement. Thus, additional elements of the strategy are to protect land in blocks of at least 65 hectares (160 acres) and to avoid fragmenting any metapopulation into more than 2 blocks of contiguous, protected natural land. Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences, provide pollinator habitat, and allow for population expansion. Finally, the natural hydrological regime, including appropriate height of the water table and periodic overland flows, must be maintained to ensure long-term survival of palmate-bracted bird's-beak at protected sites.

To prevent the irreversible decline of palmatebracted bird's-beak in the near future, the Springtown Alkali Sink metapopulation must be protected from development and from incompatible uses. In addition, appropriate measures must be taken to restore the hydrology after a hydrologic study of the watershed that encompasses the Springtown Alkali Sink has been conducted. Another high-priority task is to ascertain the genetic composition of the Woodland population. If it contains genes that differ from those in populations that are protected currently, the Woodland site should be considered for protection as a specialty reserve. If permitted development results in the loss of any natural populations, seeds should be salvaged for introduction into other suitable habitats. The occupied habitat on public land also is essential to the survival of palmatebracted bird's-beak; management to promote the continued survival of this species must continue.

Additional actions that are necessary, but of somewhat lower priority, are to determine the genetic composition and extent of the population in western Madera County, conduct surveys, develop management plans for all sites, and model population viability. The occupied habitat in Madera County is not in imminent danger of destruction, but the area is important for recovery of a number of plant and animal taxa, and longterm protection should be assured through conservation easements or other mechanisms. If the genetic variability or population size of palmate-bracted bird's-beak in the western Madera County site is low, techniques that can be used to increase population viability include augmentation (with seeds from other San Joaquin Valley populations) and habitat management. Management plans must be developed and implemented for each of the metapopulations. The plans should include monitoring to track population trends and evaluate management effectiveness. Seed samples should be collected from at least the Springtown, Woodland, and Alkali Sink/ Mendota populations following established guidelines (Center for Plant Conservation 1991) to preserve the gene pool and provide sources for reintroduction or augmentation of populations, if determined to be necessary. Matrix projection models should be developed for the Springtown Alkali Sink and San Joaquin Valley populations, as well as for any others not currently known that are counted towards recovery. To do so, demographic studies must be instituted in these populations to identify critical stages in the life cycle. Additional research may be necessary to determine appropriate management to overcome limitations to population growth.

C. KERN MALLOW (EREMALCHE KERNENSIS)

1. Description and Taxonomy

Taxonomy.—Kern mallow was first described as Eremalche kernensis, based on a specimen from the "Temblor Valley, 7 miles. northwest of McKittrick", in Kern County (Wolf 1938, p.67). Both Kearney (1951) and Munz (1958) transferred this species to the genus Malvastrum then reconsidered (Kearney 1956, Munz 1968) and returned to the original name. combinations have been suggested (Leonelli 1986) but were not validly published. The most recently-published treatments (Bates 1992, 1993) assign Kern mallow the name Eremalche parryi ssp. kernensis. However, the taxonomy of Kern mallow remains controversial in terms of its rank and its relationship to Parry's mallow (Eremalche parryi ssp. parryi). Most local botanists continue to use the scientific name Eremalche kernensis (Medlin in litt. 1995a) for this member of the mallow family (Malvaceae).

Description.—The height and habit of Kern mallow (Figure 9) vary depending on seasonal precipitation. The form can vary from single-stemmed to multiple-stemmed, with the central stem erect and the lateral stems trailing along the ground. Stem lengths at flowering may range from less than 2.5 centimeters (1 inch) to nearly 50 centimeters (20 inches). The flowers have 5 petals, and the wheel-shaped fruits are divided into single-seeded segments (Bates 1993).

Identification.—The taxonomic debate centers around the gender, color, and size of flowers indicative of Kern mallow versus Parry's mallow. Some populations in the Kern/Parry's mallow complex exhibit a condition known as gynodioecy, meaning that a population contains a mixture of plants that have only pistillate (female) flowers and plants that have only bisexual flowers (with both male and female parts). Bates (1992, 1993) considered any gynodioecious population in the Kern/Parry's mallow complex to be Kern mallow and those populations with only bisexual flowers to be Parry's mallow. On the other hand, Taylor and Davilla in litt. (1986) maintained that both Kern mallow and Parry's mallow were gynodioecious. Neither Wolf (1938) nor authors of early regional floras (Abrams 1951, Munz and Keck 1959) mentioned flower gender. Bisexual Kern mallow flowers produce fewer seeds per fruit (7 to 13) than do pistillate flowers (8 to 19). Parry's mallow and desert mallow (Eremalche exilis) fruits contain 10 to 22 and 9 to 13 segments, respectively (Abrams 1951, Munz and Keck 1959, Bates 1992, 1993, Mazer et al. in litt. 1993).

The strictest definition of Kern mallow applies only to populations in which white-flowered individuals predominate. Even in these areas, a few individuals may have pale lavender flowers (Wolf 1938, Bates 1992, Mazer et al. in litt. 1993), but lavender-flowered plants represented less than 10 percent of one population in 1994 (E. Cypher unpubl. data). Definite Parry's mallow populations consist of only pinkish-purple flowers, whereas those of questionable taxonomic affinity contain

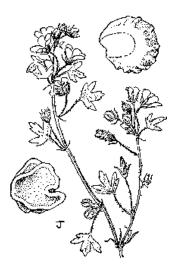


Figure 9. Illustration of Kern mallow (from Abrams 1951, with permission).

either exclusively pinkish-purple flowers or a very small proportion of white-flowered plants. Regardless of color, pistillate flowers have shorter petals than bisexual flowers in the same population (Bates 1992, 1993). Parry's mallow has larger flower parts than Kern mallow. Another closely-related species that infrequently occurs with the other two taxa is desert mallow, which has trailing stems and bisexual flowers that are smaller than those of Kern mallow (Twisselmann 1956, Twisselmann 1967, Hoover 1970, Bates 1993). The populations of Kern mallow that are predominantly white-flowered are the object of conservation concern, and thus the strict interpretation is used in the following sections unless otherwise noted.

2. Historical and Current Distribution

Historical Distribution.—Kern mallow has always had a highly-restricted distribution. In the original description, Wolf (1938) mentioned specimens from the Temblor Valley, Belridge Oil Field, and two sites west of Buttonwillow; all these occurrences were in western Kern County north of McKittrick.

Current Distribution.—A 1986 status survey reported three additional occurrences in Lokern, which is the local name for the area between Buttonwillow and McKittrick (Taylor and Davilla in litt. 1986). More intensive surveys during the past few years (Anderson et al. 1991, Olson and Magney 1992, CDFG 1995, Stebbins et al. in litt. 1992, S. Carter pers. comm.) revealed that Kern mallow occurs intermittently within an area of approximately 100 square kilometers (40 square miles) in Lokern, which is best described as a single metapopulation (Figure 10). The California Native Plant Society (Skinner and Pavlik 1994) and CDFG (1995) also accept reports of plants from three sites between Maricopa and McKittrick (in extreme western Kern County) as representing Kern mallow. Because specimens are not available to determine the color of the flowers and these sites are outside of the accepted range, they are treated here as representing Parry's mallow.

Pink-flowered plants fitting Bates' (1992, 1993) broader concept of Kern mallow are widespread. Recent reports indicated that these plants occurred in several areas of Kern County, including Buena Vista Valley, Elk Hills, Lost Hills, McKittrick Hills, Stockdale, and the Temblor Range. Recent and historical reports elsewhere included Corcoran in Kings County; the Carrizo Plain, Elkhorn Plain, Panorama Hills, and Temblor Range in San Luis Obispo County; the Cuyama Valley in Santa

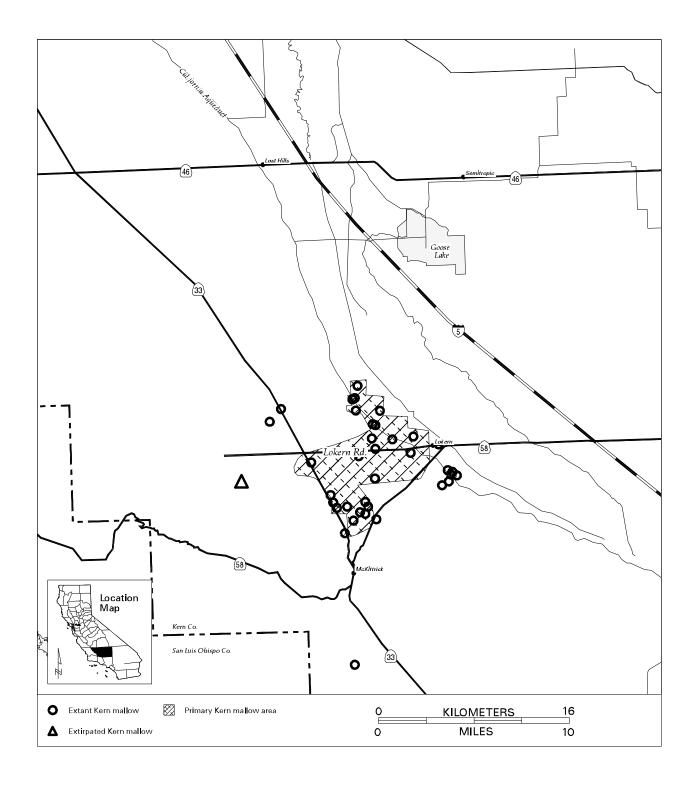


Figure 10. Distribution of Kern mallow (Eremalche kernensis).

Barbara County; and Pixley in Tulare County (Hoover 1970, Leonelli 1986, Olson and Magney 1992, Skinner and Pavlik 1994, CDFG 1995, Taylor and Davilla in litt. 1986, E. Cypher unpubl. observ., S. Wilson pers. comm.). Parry's mallow ranges from Alameda to Ventura Counties (Bates 1992).

3. Life History and Habitat

As with many arid-land annuals, the form, density, *phenology* (timing of different stages in the life cycle), and reproduction of Kern mallow vary greatly depending on precipitation.

Reproduction and Demography.—In Lokern, Kern mallow seeds typically germinate in January and February, and the plants begin flowering in March. Fruit production begins within a few days after flowers appear; flower and fruit production may continue into May if sufficient moisture is available. The seeds fall from the fruits as soon as they are mature. Seeds are capable of germinating in the following growing season, but at least some remain ungerminated. The duration of seed viability in the soil is not known. Seed dispersal agents are unknown but probably include animals and wind (Taylor and Davilla in litt. 1986, Mazer et al. in litt. 1993, E. Cypher unpubl. observ.).

Preliminary studies showed that insects facilitated pollination of Kern mallow. However, small numbers of seeds were produced when pollinators were excluded, even in pistillate plants which did not produce pollen. Possible explanations for this phenomenon were *apomixis* (i.e., seed set without fertilization), contamination of the test plants by researchers, or wind pollination. However, a higher frequency of seed set would have been expected if pollen was carried by the wind (Mazer et al. in litt. 1993). Pollen-covered bees (family Apidae) and beetles (order Coleoptera) have been observed inside Kern mallow flowers (E. Cypher unpubl. observ.), but the insects have not been identified to species.

Population size of Kern mallow varies with rainfall. Several botanists familiar with this species were unable to find Kern mallow at known locations in years of below-average rainfall (Wolf 1938, Twisselmann 1956, Bates 1992). In Lokern, Kern mallow density was nearly 10 times as high in 1995, a year of much higher than average rainfall, as in 1994, which had below-average rainfall during the growing season. Similarly, the number of flowers per plant ranged from 1 to 8 in 1994

and from 1 to over 700 in 1995 (E. Cypher unpubl. data.).

Habitat and Community Associations.—Kern mallow typically occurs in the Valley Saltbush Scrub natural community, where it grows under and around spiny and common saltbushes and in patches with other herbaceous plants, rather than in the intervening alkali scalds. Associated herbs include red brome, redstemmed filaree (Erodium cicutarium), woolly goldfields (Lasthenia minor), and white Sierran layia (Layia pentachaeta ssp. albida). Kern mallow typically grows in areas where shrub cover is less than 25 percent (Taylor and Davilla in litt. 1986). The amount of herbaceous cover varies with rainfall and microhabitat; in occupied areas of Lokern, herbaceous cover averaged 80 percent in 1993 and 48 percent in 1994 (Cypher in litt. 1994a, 1994b, E. Cypher unpubl. data). Kern mallow occasionally has reinvaded disturbed sites when existing populations remained in adjacent areas to provide sources of seed (Mitchell in litt. 1989; E. Cypher unpubl. observ.).

Kern mallow occurs on alkaline sandy loam or clay soils at elevations of 95 to 275 meters (315 to 900 feet) (Wolf 1938, CDFG 1995). Leonelli's (1986) comparison of Kern mallow habitat in Lokern with Parry's mallow habitat in the Temblor Range revealed that Kern mallow grew on soils that were more alkaline, less saline, and less sandy than those where Parry's mallow grew.

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—The loss and degradation of habitat in the Lokern area have been responsible for the decline of Kern mallow. Construction of the California aqueduct impacted Kern mallow both directly, by destroying plants in its path, and indirectly, by providing water that allowed cultivation of cotton and alfalfa in the area of endemism. The western portion of Lokern was developed for petroleum production, which eliminated Kern mallow at the type locality. Two disposal facilities for liquid waste were constructed in occupied habitat. Causes of habitat degradation, not only in Lokern, but also in the populations south to Maricopa, included installation of pipelines and transmission lines and offroad vehicle use (CDFG 1995, Taylor and Davilla in litt. 1986).

Threats to Survival.—Approximately 85 percent of the Kern mallow habitat in Lokern is privately owned and thus is vulnerable to development for many potential uses (CDFG 1995, Taylor and Davilla in litt. 1986, Presley in litt. 1994). Although the current level of petroleum production does not seem to pose a threat to the portion of the metapopulation that remains, increased production levels could cause further fragmentation and loss of localized colonies of Kern mallow. Ongoing activities such as oil exploration and maintenance of pipelines and utility corridors continue to disturb occupied habitat. The maximum levels of development and habitat disturbance that would be compatible with the continued existence of Kern mallow are unknown. A more remote threat is the possibility of spills from tank trucks traveling through the area on highways and roads.

Paradoxically, both uncontrolled grazing cessation of grazing have the potential to threaten the Kern mallow metapopulation. Sheep have grazed the Lokern area for decades (Presley in litt. 1994) and continue to graze on private lands during the growing season (E. Cypher pers. observ.). Grazing reduces the number of stems and branches on Kern mallow plants, which in turn reduces reproductive output (Mazer et al. in litt. 1993). In addition, trampling is likely to lead to localized destruction of Kern mallow in bedding areas where sheep are concentrated (Taylor and Davilla in litt. 1986). However, light to moderate grazing may serve to reduce competition in areas that are dominated by aggressive exotics (Cypher in litt. 1994b). Demographic studies indicated that the survival rate of Kern mallow seedlings was reduced in dense stands of exotic plants compared to sparsely-vegetated sites (Cypher in litt. 1994b). Furthermore, flower production was significantly increased in preliminary experiments where competitors were reduced through clipping (E. Cypher unpubl. data). The overall effects of sheep grazing on Kern mallow populations are unknown and require further investigation to determine appropriate management for the area.

Application of malathion in Lokern or other pesticides on adjacent agricultural fields could pose a threat to the long-term survival of Kern mallow by reducing pollinator populations. Malathion is sprayed periodically on natural lands in the San Joaquin Valley to control the beet leafhopper, which transmits diseases to crops (Clark in litt. 1991). If pollinator numbers were reduced, the Kern mallow metapopulation likely would experience reduced seed-set (Mazer et al. in litt. 1993). Also, if apoximis was the primary source of seeds, genetic variability could decline and the metapopulation could be more vulnerable to disease or other catastrophic events, such as has been observed in common species (Burdon and Marshall 1981).

5. Conservation Efforts

Kern mallow was federally listed as endangered in 1990 (USFWS 1990; Table 1). Even before then, Lokern was a focus for protection because a variety of endangered and threatened species occupy the area. The California Energy Commission, California Department of Water Resources, and USBLM have sponsored biological surveys in Lokern (Anderson et al. 1991, Stebbins et al. in litt. 1992, S. Carter pers. comm.). Approximately 15 percent of the occupied Kern mallow habitat, primarily on the margins of the metapopulation, is owned by USBLM and The Nature Conservancy. An interagency cooperative acquisition and management plan for the entire 17,800-hectare (44,000-acre) Lokern Conceptual Area is in draft form; participants include USBLM, CDFG, California Energy Commission, The Nature Conservancy, Center for Natural Lands Management, and USFWS. Chevron USA may contribute to preservation of the area by establishing a mitigation bank on its lands, which constitute approximately 40 percent of the conceptual area and a substantial portion of the Kern mallow habitat (Presley in litt. 1994). The draft Kern County Valley Floor Habitat Conservation Plan specifies that no more than 10 percent of the natural land in the Lokern Conceptual Area may be disturbed under its section 10(a) permit (T. James pers. comm.), but protection efforts would not necessarily target occupied Kern mallow habitat.

Efforts that specifically targeted the conservation of Kern mallow included (1) research on the demography and reproductive biology of Kern mallow funded by CDFG (Mazer et al. in litt. 1993), (2) salvage of plant specimens and seed from the Laidlaw Waste Disposal Facility by Endangered Species Recovery Program and Laidlaw in cooperation with USFWS, (3) ongoing population monitoring and research on the response of Kern mallow to sheep grazing jointly sponsored by USBLM and Endangered Species Recovery Program (Cypher in litt. 1994*a*, 1994*b*), and (4) exclusion of grazing from known Kern mallow habitat under the control of USBLM and Center for Natural Lands Management.

6. Recovery Strategy

Considering that habitat loss is the primary reason that Kern mallow is listed as an endangered species, the top-priority task for recovery is to protect habitat in Lokern. The goal is to protect 90 percent of the remaining occupied habitat. This goal is based on the recognition that some development in Lokern must be allowed for economic reasons and on the assumption that loss of an additional 10 percent of the habitat will not jeopardize the continued survival of the taxon, provided that the protected habitat is managed appropriately. Unoccupied habitat within the metapopulation also is important for population expansion and movement of pollinators and seed dispersers. Thus, additional elements of the strategy are to protect land in blocks of at least 65 hectares (160 acres) and to avoid fragmenting the metapopulation into more than 2 blocks of contiguous, protected natural land. Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion.

The long-term prospects for survival of Kern mallow would be enhanced if more than one metapopulation was protected. The preferred approach is to determine the identity of the questionable populations in other areas and protect any others that are identified through biosystematic analysis as Kern mallow, rather than to attempt artificial introductions. However, the decision as to whether to protect existing populations outside of Lokern or to plant seeds from Lokern at other sites depends on the outcome of systematic research. A biosystematic study (research that uses evidence from several disciplines to determine taxonomic affiliations) should be completed within 5 years of recovery plan approval. Moreover, if the pink-flowered and whiteflowered mallow populations are determined to represent a single taxon, the listing status for Kern mallow would need to be reevaluated.

Additional high-priority tasks are to continue demographic and ecological research. Demographic studies are a prerequisite to matrix projection modeling, which is necessary to identify vulnerable stages in the life cycle. Only if these limiting stages are managed properly can populations be assumed to be self-sustaining (Schemske et al. 1994). Research is required to determine the relative magnitude of threats posed by exotic plants and sheep and to formulate appropriate management strategies for all protected lands. Even after demographic studies are discontinued, population trends should be monitored annually and management strategies should be reassessed if the Lokern metapopulation begins to decline. Several important aspects of pollination ecology must be investigated in greater detail, including the identity of insect pollinators, their vulnerability to pesticides that are used locally, and

other mechanisms of pollen transfer. Until more specific recommendations are available from research, pollinator availability should be considered a limiting factor and pesticide spraying should be avoided in Lokern during the Kern mallow flowering period.

D. HOOVER'S WOOLLY-STAR (ERIASTRUM HOOVERI)

1. Description and Taxonomy

Taxonomy.—Hoover's woolly-star was named originally by Jepson (1943) as *Huegelia hooveri*. In a later taxonomic revision, Mason (1945) assigned the currently-accepted name of *Eriastrum hooveri* to the species. Both the scientific and common names honor Robert F. Hoover, who collected the type specimen in 1937 in Kern County, 11 kilometers (7 miles) south of Shafter (Mason 1945). Hoover's woolly-star is an inconspicuous member of the phlox family (Polemoniaceae).

Description.—The wiry stems of this species may or may not branch and vary in height from 1 to 20 centimeters (0.4 to 8 inches) at flowering (Figure 11). The leaves are thread-like and may have two narrow lobes near the base. Hoover's woolly-star has tiny (less than 5 millimeters; less than 0.2 inch long), white to pale blue flowers that are nearly hidden in tufts of woolly hair. The *stamens* (male reproductive parts) are shorter than the corolla.

Identification.—Many-flowered eriastrum (*Eriastrum pluriflorum*) frequently occurs with Hoover's woolly-star; the former has dark blue flowers that are 16 millimeters (0.6 inch) or greater in length, stamens that protrude from the corolla, and leaves with up to 10 lobes. Small-flowered *Eriastrum* species that occur within the same range are distinguished from Hoover's woolly-star by flower color and stamen length (Abrams 1951, Munz and Keck 1959, Patterson 1993, Taylor and Davilla in litt. 1986, Lewis in litt. 1992).

2. Historical and Current Distribution

Historical Distribution.—Prior to 1986, Hoover's woolly-star was known from 19 sites in 4 counties, based on herbarium collections and written observations. The majority of the occurrences were on the San Joaquin and Cuyama Valley floors, and the others were from the low

mountains at the west side of the San Joaquin Valley (Figure 12). In Kern County, Hoover's woolly-star was known from the vicinities of Lokern, Oildale, Semitropic, Shafter, and the Temblor Range. In Fresno County, known occurrences were concentrated near Kerman, Mendota, and Raisin City, except for one site each in the Jacalitos and Panoche Hills. The Cuyama Valley records consisted of one collection each from Santa Barbara and San Luis Obispo Counties (Taylor and Davilla in litt. 1986).

Current Distribution.—Hoover's woolly-star since has been discovered in Kings and San Benito Counties and at numerous additional sites in the 4 original counties, particularly in foothill areas. Most of the occurrences are concentrated in 4 metapopulations. In descending order by estimated number of individuals, these metapopulations are (1) the Kettleman Hills in Fresno and Kings Counties, (2) Carrizo Plain - Elkhorn Plain - Temblor Range - Caliente Mountains - Cuyama Valley - Sierra Madre Mountains in San Luis Obispo, Santa Barbara, and extreme western Kern Counties, (3) Lokern - Elk Hills - Buena Vista Hills - Coles Levee -Taft - Maricopa in Kern County, and (4) Antelope Plain -Lost Hills - Semitropic in Kern County. Small, isolated populations occur in scattered areas including the Alkali Sink Ecological Reserve and the Guijarral, Jacalitos, Panoche, and Tumey Hills in Fresno County; Buttonwillow, Devil's Den, Lamont, Midway Valley, and Rosedale in Kern County; and the Panoche Hills in San Benito County (Lewis in litt. 1992, 1994b, CDFG 1995, Holmstead in litt. 1993, Danielsen et al. in litt.

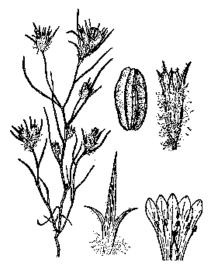


Figure 11. Illustration of Hoover's woolly-star (from Abrams 1951, with permission).

1994, EG&G Energy Measurements in litt. 1995). According to Skinner and Pavlik (1994), the species also occurs in Tulare County.

3. Life History and Habitat

Reproduction and Demography.—Hoover's woolly-star is an annual, but the seeds germinate later in the growing season than do those of many of the associated annual plants. Seedlings may emerge from January or February until mid-April (Taylor and Davilla in litt. 1986, E. Cypher unpubl. data). The typical flowering period for Hoover's woolly-star extends from March into June (Munz and Keck 1959, Skinner and Pavlik 1994, Lewis in litt. 1992, Cypher in litt. 1994a). Pollination ecology has not been investigated. The tiny seeds probably are dispersed by wind or by tumbling of dead stems (Taylor and Davilla in litt. 1986). Unlike many other annuals, dead stems of Hoover's woolly-star may persist until the next growing season (Lewis in litt. 1992).

Within metapopulations, Hoover's woolly-star typically occurs as scattered groups of plants, with each group occupying an area of less than 0.4 hectare (1 acre) (Lewis in litt. 1994b). Densities are highly variable among sites and among years. In 1993, average densities reported for Hoover's woolly-star in occupied habitat were 3.6 per square meter (0.3 per square foot) at Elk Hills (EG&G Energy Measurements unpubl. data), 8.4 per square meter (0.8 per square foot) in Lokern, and 10.3 per square meter (0.9 per square foot) in the Kettleman Hills (Cypher in litt. 1994a). However, metapopulation densities would be considerably smaller due to the presence of unoccupied stretches between the groups of plants. Densities of Hoover's woolly-star fluctuate from year to year and are highest in years of above-average precipitation (Holmstead in litt. 1993). At Elk Hills, densities in natural colonies were 5 to 15 times greater in 1993, a year of above-average rainfall, than in 1991, which was a year of average rainfall (EG&G Energy Measurements in litt. 1995).

Habitat and Community Associations.—Hoover's woolly-star seems to be much more adaptable than other endemic plants of the San Joaquin Valley. Optimal habitats for Hoover's woolly-star are characterized by stabilized silty to sandy soils, a low cover of competing herbaceous vegetation, and the presence of cryptogamic crust (a layer of moss, lichen, and algae). However, this species also has been found on loamy soils, in areas of dense vegetation, and in areas lacking cryptogamic crust (Taylor and Davilla in litt. 1986, Cypher in litt. 1994a,

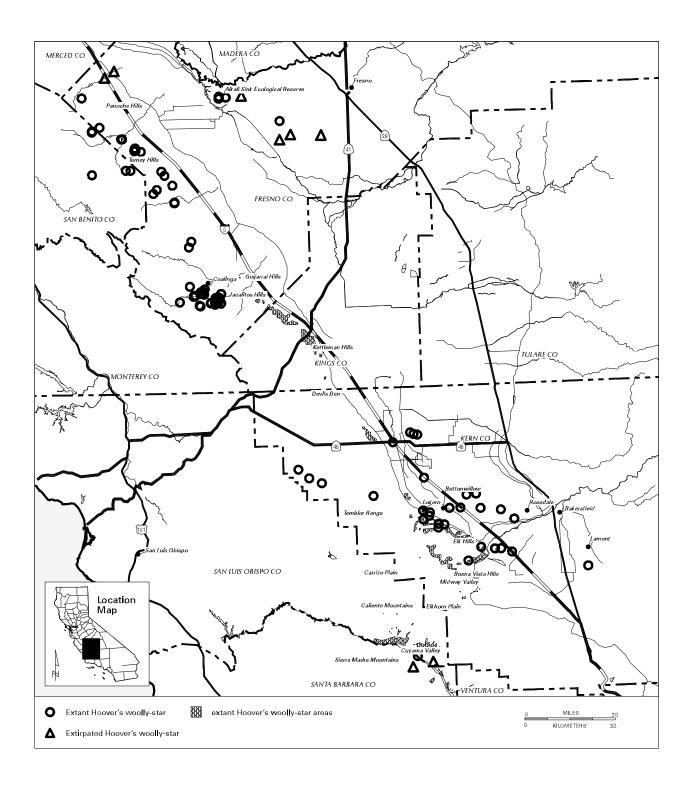


Figure 12. Distribution of Hoover's woolly-star (Eriastrum hooveri).

Lewis in litt. 1994b, EG&G Energy Measurements in litt. 1995). Hoover's woolly-star may reinvade disturbed soil surfaces such as well pads and dirt roads within 1 year after the disturbance ceases if seed sources remain in the vicinity (Holmstead in litt. 1993, Danielsen et al. in litt. 1994, EG&G Energy Measurements unpubl. data, R. Lewis pers. comm.). In fact, this species may benefit from light to moderate soil disturbance in areas that are densely vegetated by exotic plants (Holmstead and Anderson in litt. 1993, EG&G Energy Measurements unpubl. data).

Populations of Hoover's woolly-star occur in alkali sinks, washes, on both north- and south-facing slopes, and on ridgetops. This species occurs in a wide variety of plant communities. Most are characterized by shrubs such as common saltbush, seepweed, and matchweed (Gutierrezia californica), but shrub cover in occupied habitats typically is less than 20 percent. Herbaceous plant species frequently found in association with Hoover's woolly-star include red brome, goldfields, many-flowered eriastrum, and red-stemmed filaree. Populations of Hoover's woolly-star have been reported at elevations ranging from 50 to 915 meters (165 to 3,000 feet) (CDFG 1995, Taylor and Davilla in litt. 1986, Holmstead in litt. 1993, Cypher in litt. 1994a, Danielsen et al. in litt. 1994, Lewis in litt. 1992, 1994b, EG&G Energy Measurements in litt. 1995).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Valley-floor populations of Hoover's woolly-star have been destroyed primarily by farming operations and secondarily by urban development (Taylor and Davilla in litt. 1986, E. Cypher pers. observ.).

Threats to Survival.—Occurrences of Hoover's woolly-star in the vicinity of Buttonwillow, Lost Hills, Rosedale and sites along Interstate Highway 5 are threatened by commercial development. Agricultural conversion continues to threaten several populations on the Valley floor. Flooding, as a result of high precipitation, groundwater recharge programs, agricultural wastewater diversion, or waterfowl management, could destroy populations in low-lying areas (Skinner and Pavlik 1994, Taylor and Davilla in litt. 1986). Dense growth of associated vegetation, such as in areas where exotic grasses dominate or where fire has been suppressed, may create unsuitable conditions for growth of Hoover's woolly-star (J. Hinshaw pers. comm.). Hoover's woolly-star remains primarily in hilly areas, many of which are oil fields; petroleum production does not pose a threat in most cases but could be detrimental if large areas of occupied habitat were disturbed. In particular, privatization of the Naval Petroleum Reserve near Taft could lead to greater surface disturbance if rates of exploration and production were increased.

5. Conservation Efforts

Hoover's woolly-star was federally listed as threatened in 1990 (USFWS 1990; Table 1). Field surveys sponsored by USBLM, California Energy Commission, U.S. Department of Energy, California Department of Water Resources, and USFWS resulted in the discovery of many new occurrences of Hoover's woolly-star between 1986 and 1993 (Anderson et al. 1991, Taylor and Davilla in litt. 1986, Lewis in litt. 1992, 1994b, Stebbins et al. in litt. 1992, Holmstead in litt. 1993, EG&G Energy Measurements in litt. 1995). Thus, approximately one-third of the individual plants are located on public land, most of which is administered by USBLM and U.S. Department of Energy (Holmstead in litt. 1993, Lewis in litt. 1994b). Through a consultation with USFWS, U.S. Department of Energy has agreed to implement conservation measures at Elk Hills which will benefit a variety of listed and rare species. Specific measures that will contribute to the recovery of Hoover's woolly-star include dedication of a conservation area containing the species, periodic monitoring of representative sites, and a multi-year floristic survey of Naval Petroleum Reserve-1 in California (B. Cypher pers. comm.). In addition, U.S. Department of Energy has sponsored several research projects on the ecology of Hoover's woolly-star, its response to oilfield activity, and the conditions under which it will recolonize disturbed areas (Holmstead in litt. 1993, Holmstead and Anderson in litt. 1993, EG&G Energy Measurements in litt. 1995, J. Hinshaw pers. comm.). Preliminary studies on the demography of Hoover's woolly-star and its response to grazing were conducted in 1993 with funding provided by USBLM, CDFG, and Endangered Species Recovery Program (Cypher in litt. 1994a). Hoover's woolly-star also has benefited from the acquisition of conservation lands for listed animals. It is known to occur on the Alkali Sink Ecological Reserve, Buttonwillow Preserve, Carrizo Plain Natural Area, Coles Levee Ecosystem Preserve, Lokern Natural Area, and Semitropic Ridge Preserve. In 1990, Mobil Oil Corporation constructed exclosures around Hoover's woolly-star on their lands in Lost Hills (Lewis in litt. 1994b).

6. Recovery Strategy

Recovery of Hoover's woolly-star can be accomplished using public lands and other areas already dedicated for conservation. As with the other listed plants, the goal is to protect populations throughout the species' range and representing a variety of topographic positions and community types. Considering that habitat conversion is ongoing in valley-floor areas and that oil production could increase on public lands, the continued existence of populations cannot be assumed unless a specific commitment is made to protect them from incompatible uses. Some amount of unoccupied suitable habitat is important to allow population fluctuations among years, and a buffer zone is important to minimize external influences such as pesticide drift. Thus, a minimum block size of 16 hectares (40 acres) is recommended, with an average density of 625 Hoover's woolly-star plants per hectare (250 per acre). Monitoring must continue at representative sites within each metapopulation to determine trends. Management strategies and recovery needs should be reassessed if population densities at the monitoring sites decline over 3 or more successive years of above-average rainfall that are separated by one or more years of below-average rainfall.

E. SAN JOAQUIN WOOLLY-THREADS (LEMBERTIA CONGDONII)

1. Description and Taxonomy

Taxonomy.—In 1883, Gray named San Joaquin woolly-threads as Eatonella congdonii. The type specimen had been collected by Congdon near Deer Creek (Tulare County) in that same year. The current name, Lembertia congdonii, was published by Greene in 1897, who determined that San Joaquin woolly-threads should be separated from snowy eatonella (Eatonella nivea). Subsequent taxonomists have upheld Greene's taxonomy (Johnson 1993, Taylor in litt. 1989). San Joaquin woolly-threads is the sole species in the genus Lembertia, which is in the aster family (Asteraceae).

Description.—The common name "woolly-threads" is derived from the many long (up to 45 centimeters; 18 inches), trailing stems covered with tangled hairs. However, San Joaquin woolly-threads plants also can be tiny (less than 7 centimeters; less than 3 inches) and erect

with a single stem (Cypher in litt. 1994a). The tiny, yellow flower heads are clustered at the tips of the stems and branches (Figure 13). Each flower head is approximately 6 millimeters (0.25 inch) long and contains two types of *florets* (the tiny flowers characteristic of the aster family); the 4 to 7 outer florets differ in shape from the numerous inner florets. The two types of florets produce *achenes* (tiny, one-seeded fruits) that also differ in shape (Johnson 1993, Taylor in litt. 1989).

Identification.—San Joaquin woolly-threads differs from snowy eatonella in the shape of the florets and achenes and in geographical range (Munz and Keck 1959, Johnson 1993, Taylor in litt. 1989).

2. Historical and Current Distribution

Historical Distribution.—The historical range of San Joaquin woolly-threads is based on 47 herbarium specimens and literature reports dating from 1883 to 1983; 30 of the occurrences were from the floor of the San Joaquin Valley, four were from the Cuyama Valley, and the remainder were in the hills west of the San Joaquin Valley (Figure 14). These occurrences were concentrated in eight areas (in descending order of abundance): (1) the plains between Avenal and Mendota in Kings and Fresno Counties, (2) from Bakersfield to Shafter in Kern County, (3) the inner Coast Ranges of western Fresno and eastern San Benito Counties, (4)



Figure 13. Illustration of San Joaquin woolly-threads (from Abrams and Ferris 1960, with permission).

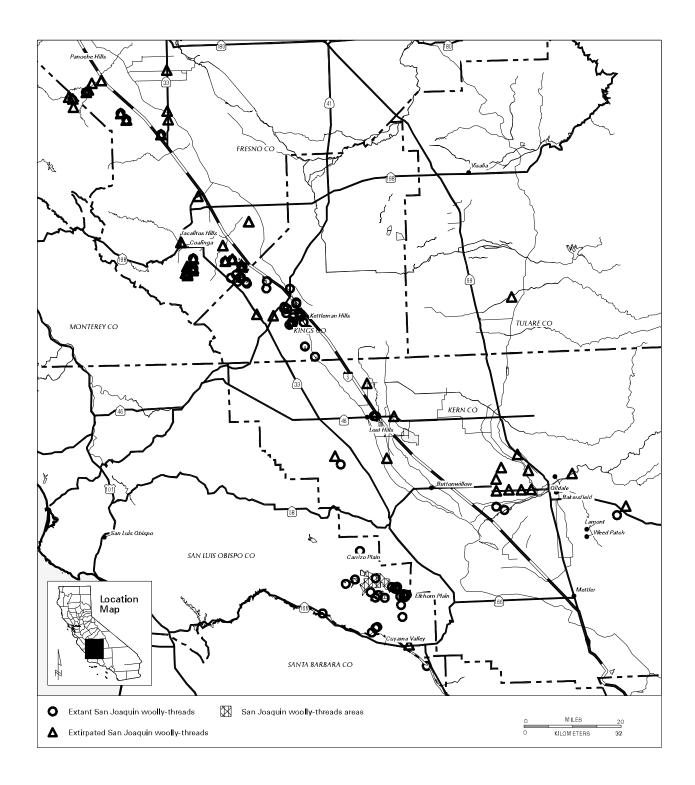


Figure 14. Distribution of San Joaquin woolly-threads (Lembertia congdonii).

from north of Lokern to Lost Hills in Kern County, (5) the Carrizo and Elkhorn Plains in San Luis Obispo County, (6) the Cuyama Valley in Santa Barbara County, (7) east of Edison in Kern County, and (8) the type locality. However, 33 of the historical occurrences had been eliminated by 1989 (Taylor in litt. 1989).

Current Distribution.—Many new occurrences of San Joaquin woolly-threads have been discovered since 1986, primarily in the hills and plateaus west of the San Joaquin Valley. These constitute four metapopulations and several small, isolated populations. The largest metapopulation occurs on the Carrizo Plain Natural Area, where the occupied habitat totaled over 1,100 hectares (2,800 acres) in 1993 (Lewis in litt. 1993b), which was a particularly favorable year. In years of lower rainfall, the occupied area is much smaller (E. Cypher unpubl. observ.). Much smaller metapopulations are found in Kern County near Lost Hills, in the Kettleman Hills of Fresno and Kings Counties, and in the Jacalitos Hills of Fresno County. The isolated occurrences are known from the Panoche Hills in Fresno and San Benito Counties, the Bakersfield vicinity, and the Cuyama Valley (CDFG 1995, Taylor in litt. 1989, Stebbins et al. in litt. 1992, Lewis in litt. 1993b, Taylor and Buck in litt. 1993, USBLM in litt. 1994, S. Carter pers. comm., R. Lewis pers. comm., S. Wilson pers. comm.).

3. Life History and Habitat

Reproduction and Demography.—San Joaquin woolly-threads is an annual herb, and its phenology varies with weather and site conditions. In years of below-average precipitation, few seeds of this species germinate, and those that do typically produce tiny plants. Seed germination may begin as early as November but usually occurs in December and January. San Joaquin woolly-threads typically flowers between late February and early April, but flowering may continue into early May if conditions are optimal (B. Delgado pers. comm.). Populations in the northern part of the range flower earlier than does the Carrizo Plain metapopulation. Each plant may have from 1 to more than 400 flower heads. Seed production depends on plant size and the number of flower heads; in 1993, achene production ranged from 10 to 2,500 seeds per individual (Mazer and Hendrickson in litt. 1993b, Cypher in litt. 1994a, E. Cypher unpubl. data). The seeds are shed immediately upon maturity, and all trace of the plants disappears rapidly after their death in April or May. Seed

dispersal agents are unknown, but possible candidates include wind, water, and animals. Seed-dormancy mechanisms apparently allow the formation of a substantial seed bank in the soil (Twisselmann 1967, Taylor in litt. 1989, Lewis in litt. 1993*b*, Mazer and Hendrickson in litt. 1993*b*, Cypher in litt. 1994*a*).

Insect pollinators are not required for seed-set in San Joaquin woolly-threads (Mazer and Hendrickson in litt. 1993b). However, animals may be important to this plant species in other ways. On the Carrizo Plain Natural Area, giant kangaroo rat activity contributes to greater plant size and flower head production in San Joaquin woolly-threads, probably by increasing available soil nutrients and reducing competition from other plants. The microhabitat offered by giant kangaroo rat *precincts* also contributes to earlier seed germination and maturation of San Joaquin woolly-threads, possibly because precinct surfaces are warmer than the surrounding area during the winter months (Cypher in litt. 1994a, 1994b).

Habitat and Community Associations.—San Joaquin woolly-threads occurs in Nonnative Grassland, Valley Saltbush Scrub, Interior Coast Range Saltbush Scrub, and Upper Sonoran Subshrub Scrub (Cypher in litt. 1994a). This species typically occupies microhabitats with less than 10 percent shrub cover, although herbaceous cover may be either sparse or dense, and cryptogamic crust may or may not be present. Plant species that often occur with San Joaquin woolly-threads include red brome, red-stemmed filaree, goldfields, Arabian grass (Schismus spp.), and mouse-tail fescue (Vulpia myuros). Hoover's woolly-star often occurs in populations of San Joaquin woolly-threads, although the reverse is not true (Taylor in litt. 1989, Lewis in litt. 1993b, Taylor and Buck in litt. 1993, Cypher in litt. 1994a). In two cases, San Joaquin woolly-threads was found at low densities in previously disced areas that were adjacent to undisturbed populations (Lewis in litt. 1993*b*, Taylor and Buck in litt. 1993).

San Joaquin woolly-threads occurs on neutral to subalkaline soils that were deposited in geologic times by flowing water. On the San Joaquin Valley floor, this species typically is found on sandy or sandy loam soils, particularly those of the Kimberlina series, whereas on the Carrizo Plain it occurs on silty soils. San Joaquin woolly-threads frequently occurs on sand dunes and sandy ridges as well as along the high-water line of washes and on adjacent terraces. Occurrences have been

reported at elevations ranging from approximately 60 to 260 meters (200 to 850 feet) on the Valley floor and surrounding hills, and from 600 to 800 meters (2,000 to 2,600 feet) in San Luis Obispo and Santa Barbara Counties (Hoover 1937, CDFG 1995, Taylor in litt. 1989, Lewis in litt. 1993*b*, Taylor and Buck in litt. 1993, E. Cypher unpubl. observ., R. van de Hoek pers. comm.).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—Habitat loss was responsible for the decline of San Joaquin woolly-threads on the floors of the San Joaquin and Cuyama Valleys, where the majority of the occurrences were eliminated by intensive agriculture. In addition, several sites in and around Bakersfield were eliminated by urban development, and two others between Lokern and Lost Hills apparently were destroyed as a result of intensive oilfield development (CDFG 1995, Taylor in litt. 1989).

Threats to Survival.—The Lost Hills metapopulation is on private land in an area of high value for commercial development and agriculture (Taylor in litt. 1989, Taylor and Buck in litt. 1993). Several occurrences in the Kettleman Hills, the Jacalitos Hills, and west of Bakersfield are in low-density oilfields; the plants do not seem to be threatened by the current level of activity but could be destroyed by more intensive use of the areas (Lewis in litt. 1993b, E. Cypher unpubl. observ.). Preliminary studies suggested that both competition from exotic plants and spring grazing reduced survival rates, but not flower production, in San Joaquin woollythreads (E. Cypher unpubl. data). Trampling also reduces survival in areas where livestock congregate, such as around water troughs (Taylor in litt. 1989, Lewis in litt. 1993b, Mazer and Hendrickson in litt. 1993b, Cypher in litt. 1994a, 1994b, E. Cypher unpubl. data, B. Delgado pers. comm.). However, removal of livestock from areas that have been grazed continuously for decades would be inadvisable without additional data, because grazing may in fact be a useful management tool to control competition from exotic plants (E. Cypher unpubl. observ.).

5. Conservation Efforts

San Joaquin Woolly-threads was federally listed as endangered in 1990 (USFWS 1990; Table 1). USBLM biologists have conducted extensive surveys for San Joaquin woolly-threads. Thus, many of the occurrences that are known currently are on lands administered by USBLM, including the entire Carrizo Plain Natural Area

metapopulation, part of the Kettleman Hills metapopulation, and the sites in the Jacalitos and Panoche Hills. Within these areas, fences have been erected around several small occurrences of San Joaquin woolly-threads that showed evidence of trampling by livestock (Lewis in litt. 1993b, S. Carter pers. comm., B. Delgado pers. comm.). The Carrizo and Elkhorn Plains and the Kettleman Hills are proposed Areas of Critical Environmental Concern, which would restrict activities on USBLM lands in those regions (USBLM in litt. 1993). USBLM and Endangered Species Recovery Program are cooperatively monitoring selected populations and conducting research on the impacts of livestock grazing (Cypher in litt. 1994a, 1994b, USBLM in litt. 1994).

Other groups also are contributing to conservation of this species. CDFG funded research on the demography, reproductive biology, and ecology of San Joaquin woolly-threads (Mazer and Hendrickson in litt. 1993b, Cypher in litt. 1994a). California Energy Commission, U.S. Department of Energy, and California Department of Water Resources have sponsored surveys for rare plants, including San Joaquin woolly-threads, in various parts of the southern San Joaquin Valley (Anderson et al. 1991, Stebbins in litt. 1993, B.L. Cypher pers. comm.). The Metropolitan Bakersfield Habitat Conservation Plan identified a 121-hectare (300-acre) area west of Bakersfield as a preserve acquisition target for this species (Metropolitan Bakersfield Habitat Conservation Plan Steering Committee in litt. 1994). If the Kern County Valley Floor Habitat Conservation Plan is implemented as currently proposed, private landowners in the vicinity of Lost Hills would be offered incentives to protect San Joaquin woolly-threads habitat (T. James pers. comm.).

6. Recovery Strategy

The recovery goal for San Joaquin woolly-threads is similar to that for the other endangered plant species in this plan: to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the species and in a variety of appropriate natural communities. A sufficient number of natural populations exist that reintroduction should not be necessary, provided that the existing sites are protected and managed properly. Unoccupied habitat within metapopulations also should be protected to allow for population fluctuations with rainfall and to facilitate seed dispersal. Thus, additional elements of the strategy are to protect land in blocks of at least 65 hectares (160 acres), which have an average density of at least 1,000

San Joaquin woolly-threads plants per hectare (400 plants per acre); and to avoid fragmenting any metapopulation into more than 2 blocks of contiguous, protected natural land. Finally, buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion.

The top-priority task to ensure the survival of San Joaquin woolly-threads is to protect existing habitat in the San Joaquin Valley. Other actions that are necessary for recovery include protection and appropriate management of populations on public land and annual monitoring of representative sites within each metapopulation. Monitoring is particularly important in some of the smaller populations, including the Lost Hills, Jacalitos Hills, and Kettleman Hills metapopulations and the Panoche Hills population to determine whether densities are increasing, decreasing, or remaining stable. Monitoring can verify that existing management strategies are having the desired effect or draw attention to incompatible land uses.

F. BAKERSFIELD CACTUS (OPUNTIA BASILARIS VAR. TRELEASEI)

1. Description and Taxonomy

Taxonomy.—The taxonomy of Bakersfield cactus has not been accepted universally, even though it was named nearly a century ago. Originally, Bakersfield cactus was treated as a full species, Opuntia treleasii (Coulter 1896). The type locality was given as "Caliente, in the Tehachapi Mountains" (Coulter 1896, p. 434), which is in Kern County. Shortly thereafter, Toumey (1901) renamed Bakersfield cactus as a variety of beavertail cactus (Opuntia basilaris), resulting in the combination O. basilaris var. treleasii. Griffiths and Hare (1906) considered Bakersfield cactus a distinct species and subdivided it into two varieties, O. treleasii var. treleasii and var. kernii. Britton and Rose (1920) corrected the spelling of the epithet to treleasei to be consistent with the name of the original collector, William Trelease. In the most recent treatment (Parfitt and Baker 1993), the scientific name of Bakersfield cactus is given as O. basilaris var. treleasei. However, some experts consider Bakersfield cactus to be a full species (Bowen in litt. 1987a, R. van de Hoek pers. comm.).

Description.—Like other beavertail cacti, Bakersfield cactus (Figure 15) has fleshy, flattened, green stems (pads). The pads of Bakersfield cactus vary in outline from rounded, heart-shaped, or diamond-shaped to nearly cylindrical. A single plant may consist of hundreds of pads, which originate both at ground level and from the tips of other pads. The number of individuals in a population may be difficult to determine because pads from adjacent plants often overlap. Thus, cactus populations usually are described by the number of clumps (groups of pads that are rooted at the same point) rather than as a number of individuals. Clumps of Bakersfield cactus can grow up to 35 centimeters (14 inches) high and 10 meters (33 feet) across (R. van de Hoek pers. comm.). The pads and fruits are dotted with eye-spots, which are rounded structures that contain barbed bristles. Tiny leaves are produced on the youngest pads of beavertail cacti but are shed quickly. Bakersfield cactus has showy magenta flowers. The dry fruits are the size and shape of small eggs and may contain grayish-white seeds (Munz and Keck 1959, Parfitt and Baker 1993). Bakersfield cactus typically has 22 chromosomes, but plants with 33 chromosomes were found in several populations (Pinkava et al. 1977, R. van de Hoek pers. comm.).

Identification.—Bakersfield cactus is unique among the varieties of *O. basilaris* in that the eye-spots contain spines in addition to the bristles. Other features of Bakersfield cactus that differentiate it from related beavertail cacti include the smooth *pad* surfaces, cylindrical pad bases, non-sunken eye-spots, and longer (up to 5 millimeters [0.2 inch]) leaves. The two varieties

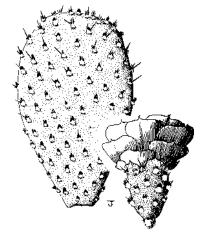


Figure 15. Illustration of Bakersfield cactus (from Abrams and Ferris 1960, with permission).

of *O. treleasei* differ from each other in that variety *treleasei* has spines less than 7 millimeters (0.3 inch) long (which may be longer or shorter than the associated bristles) and eye-spots even with the pad surface, whereas variety *kernii* has spines longer than 7 millimeters (0.3 inch) and raised eye-spots (Griffiths and Hare 1906, ESA Planning and Environmental Services, in litt. 1986a, Bowen in litt. 1987a).

2. Historical and Current Distribution

Historical Distribution.—Bakersfield cactus is endemic to a limited area of central Kern County in the vicinity of Bakersfield. The CDFG (1995) considered the pre-1987 reports to represent approximately 33 occurrences. However, based on written descriptions (Twisselmann 1967), historical photographs (Britton and Rose 1920, Benson 1982), topography, and deductions from plant morphology, the populations most likely were more or less continuous (R. van de Hoek pers. comm.). As of 1987, the northern, southern, eastern, and western limits of the known range, respectively, were Granite Station (R. van de Hoek pers. comm.), Comanche Point, Caliente, and Oildale (CDFG 1995). occurrences of Bakersfield cactus in Los Angeles and San Bernardino Counties, California, and Mohave County, Arizona (Benson 1969) have been attributed to misidentification of other cactus taxa (Bowen in litt. 1987b).

Current Distribution.—Approximately one-third of the historical occurrences of Bakersfield cactus have been eliminated, and the remaining populations are highly fragmented. However, the range was extended to the south when several occurrences were discovered in the late 1980s in south-central Kern County, just north of Wheeler Ridge (Figure 16). The extant occurrences may be grouped into the following areas of concentration: (1) Caliente Creek drainage (Caliente-Bena Hills), (2) Comanche Point, (3) Cottonwood Creek, (4) Fairfax Road-Highway 178-Highway 184-Kern Bluffs-Hart Park, (5) Fuller Acres, (6) Granite Station, (7) mouth of Kern Canyon, (8) Oildale - Kern River Oil Field - Round Mountain Road (separated from area #4 by the Kern River), (9) Poso Creek, (10) Sand Ridge, and (11) Wheeler Ridge - Pleito Hills (CDFG 1995, Moe in litt. 1989).

3. Life History and Habitat

Few details on the life history of Bakersfield cactus are available. The fleshy stems, tiny, short-lived leaves, shallow root systems, and specialized physiology common to most members of the cactus family are adaptations to growth in arid environments (Benson 1982).

Reproduction and Demography.—Bakersfield cactus is a perennial. The life span of wild plants has not been determined, but clumps in cultivation at the Rancho Santa Ana Botanic Garden in Claremont, California, survived for 48 years, until extremely wet winter weather caused the pads to rot (R. van de Hoek pers. comm.). Bakersfield cactus typically flowers in May (Munz and Keck 1959). Reproductive biology of this taxon has not been studied, but certain other Opuntia species require cross-pollination for seed-set and many are pollinated by bees (Benson 1982, Spears 1987, Osborn et al. 1988). Vegetative reproduction, which is the production of new plants from sources other than seed, is typical in Bakersfield cactus and several related species (Benson 1982). Fallen pads root easily if sufficient water is available (Twisselmann 1967, Benson 1982, Mitchell in litt. 1988), but Bakersfield cactus does not survive prolonged inundation (ESA Planning and Environmental Services, in litt. 1986a). Bakersfield cactus produces seeds infrequently. Van de Hoek (pers. comm.) noted that the frequency of seed set in extant populations is similar to the proportion of seeds he observed in herbarium specimens. Cactus seeds require warm, wet conditions to germinate, a combination which is extremely rare in the Bakersfield area (Benson 1982). Pads may be dispersed by flood waters (ESA Planning and Environmental Services, in litt. 1986a), but seed dispersal agents are unknown.

The total population of Bakersfield cactus was not estimated historically. Densely-spaced clumps of cactus once covered an estimated area of 6.5 by 0.8 kilometer (4 by 0.5 mile) from the Caliente Creek floodplain onto Sand Ridge (Twisselmann 1967). Historical photographs showing extensive stands of Bakersfield cactus (Britton and Rose 1920, Benson 1982) are believed to have been taken southwest of Sand Ridge near the eastern margin of the Kern Lake bed (R. van de Hoek pers. comm.). When the known sites were last inventoried, fewer than 20,000 clumps of Bakersfield cactus were estimated to remain. Only 4 areas had populations of 1,000 clumps or more: Comanche Point, Kern Bluff, north of Wheeler Ridge, and Sand Ridge (CDFG 1995, Moe in litt. 1989, R. van de Hoek pers. comm.). The metapopulations reported to incorporate the greatest morphological diversity included those in the Bena and Caliente Hills, Kern Canyon, and

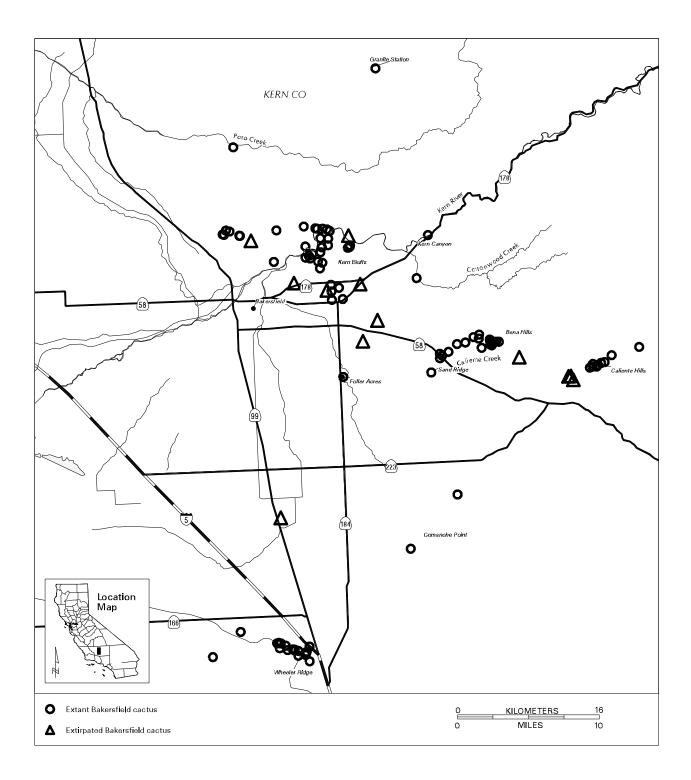


Figure 16. Distribution of Bakersfield cactus (Opuntia basilaris var. treleasei).

Sand Ridge (ESA Planning and Environmental Services, in litt. 1986a, Bowen in litt. 1987b, Moe in litt. 1989).

Habitat and Community Associations.—Soils supporting Bakersfield cactus typically are sandy, although gravel, cobbles, or boulders also may be present. Known populations occur on flood plains, ridges, bluffs, and rolling hills (CDFG 1995, ESA Planning and Environmental Services, in litt. 1986a). Bakersfield cactus is a characteristic species of the Sierra-Tehachapi Saltbush Scrub plant community (Holland 1986, Griggs et al. 1992), but populations near Caliente are in Blue Oak Woodland and the Cottonwood Creek population is in riparian woodland (CDFG 1995, ESA Planning and Environmental Services, in litt. 1986a, R. van de Hoek pers. comm.). Many Bakersfield cactus sites support a dense growth of red brome and other annual grasses (Cypher in litt. 1994a). Sand Ridge is characterized by sparse vegetation (ESA Planning and Environmental Services, in litt. 1986a, Cypher in litt. 1994a) and a preponderance of native species such as California filago (Filago californica) and yellow pincushion (Chaenactis glabriuscula). Historical records indicate that the majority of Bakersfield cactus occurred at elevations ranging from 140 to 260 meters (460 to 850 feet). The highest-elevation population is at 550 meters (1,800 feet) near Caliente and the lowest remaining is at 121 meters (396 feet) at Fuller Acres (CDFG 1995).

4. Reasons for Decline and Threats to Survival

Reasons for Decline.—The primary reason for the decline of Bakersfield cactus was habitat loss. formerly extensive tracts of Bakersfield cactus near Edison and Lamont were destroyed by conversion to row crops and citrus groves (Twisselmann 1967); much of the conversion occurred prior to 1931 (Benson 1982). Residential development eliminated numerous occurrences in northeast Bakersfield between Mount Vernon Avenue and Morning Drive in recent years (CDFG 1995). Petroleum production has contributed to habitat loss and fragmentation, particularly in the vicinity of Oildale. Populations near Hart Park, the Kern Bluffs, Oildale, Fairfax Road, and parts of Sand Ridge have been degraded by off-road vehicle activity, trash dumping, and sand and gravel mining. Overgrazing may have damaged plants near Hart Park, Mettler, and Caliente, and flooding decimated populations along Caliente Creek and the Kern River (CDFG 1995, Nelson in litt. 1983, Bowen in litt. 1987b, Mitchell in litt. 1988, Moe in litt. 1989, R. van de Hoek pers. comm.). Air pollution is suspected to have contributed to the decline of Bakersfield cactus (Messick 1987).

Threats to Survival.—All the causes of decline continue to threaten existing populations of Bakersfield cactus. Almost all the known sites are on private land, much of which has commercial value. Residential development constitutes the most serious threat currently, especially in the greater Fairfax Road-Kern Bluff and Round Mountain Road areas. Conversion for either agricultural or residential use is possible near Wheeler Ridge. Inundation could be an intermittent problem for populations in floodplains and is a remote possibility for occurrences near the California Aqueduct; the largest concentration of clumps in the Wheeler Ridge metapopulation is situated adjacent to an overflow drain for the Aqueduct, which could lead to flooding if an earthquake occurred anywhere along its length (R. van de Hoek pers. comm.). Even the 2 protected populations (see Conservation Efforts) are adjacent to agricultural land and could be impacted by pesticide drift. Both offroad vehicle use and mining continue to degrade the populations mentioned earlier.

Direct competition from introduced, annual grasses is believed to threaten the survival of mature Bakersfield cactus plants and to hinder the establishment of new plants (ESA Planning and Environmental Services, in litt. 1986a, Mitchell in litt. 1988). Indirect effects from exotic grasses also may threaten Bakersfield cactus in several ways. First, the dense herbaceous growth may promote a greater fire frequency and intensity than would have occurred with the sparse native vegetation typical in historical times. The effect of repeated fires has not been determined. However, survival of Bakersfield cactus plants was monitored following single fire events at Sand Ridge (Hewett in litt. 1987) and near the Rio Bravo Hydroelectric Plant in Kern Canyon (Lawrence in litt. 1987, George Lawrence and Associates in litt. 1988). All Bakersfield cactus clumps survived the fires at both sites, despite browning and wilting of the pads. During the following spring, cactus plants that were subject to lowintensity flames flowered, but those subject to moderateintensity flames produced only vegetative growth. The effected cactus individuals near Rio Bravo were still alive 1 year following the fire, but no further observations were made of plants in either treatment area. Second, dense grass cover may harbor insects that damage cactus, which has been demonstrated with related species of Opuntia in Nebraska grasslands (Burger and Louda 1994). Third, the moist microclimate created by dense herbaceous growth may promote growth of decay organisms and cause pads to rot in years of above-average precipitation (E. Cypher unpubl. observ.).

A lack of genetic diversity may threaten some populations of Bakersfield cactus. Contributing factors to this problem include the small size of many populations (Moe in litt. 1989), a lack of gene flow between populations, and infrequent sexual reproduction (Messick 1987). Populations low in genetic variation are more vulnerable to diseases and parasites (Burdon and Marshall 1981) and to chance events, including environmental fluctuations, catastrophes, and genetic drift (Menges 1991).

5. Conservation Efforts

Bakersfield cactus was federally and state-listed as endangered in 1990 (USFWS 1990). The Nature Conservancy began preservation efforts for Bakersfield cactus over 25 years ago by purchasing a portion of Sand Ridge (Twisselmann 1969). Recently, The Nature Conservancy doubled the size of the Sand Ridge Nature Preserve, to 111 hectares (275 acres), by acquiring a remnant of the Caliente Creek wash at the eastern base of the ridge. Funding levels for the preserve are insufficient to allow intensive monitoring or management trials (R. Tollefson pers. comm.).

The California Department of Water Resources has set aside 33 hectares (81 acres) adjacent to the California Aqueduct as a reserve for Bakersfield cactus through consultations with USFWS and CDFG. Management plans for the reserve have not yet been developed, but informal monitoring of the population is underway (K. Brown pers. comm.). The reserve includes perhaps 30 percent of the clumps in the Wheeler Ridge metapopulation (R. van de Hoek pers. comm.). The only other site on public land is under the control of the Kern County Department of Parks and Recreation, where a few clumps occur adjacent to Hart Park. However, protection of Bakersfield cactus is neither the purpose nor a priority for the site (Moe in litt. 1989).

Salvage efforts have been undertaken by local members of the California Native Plant Society, who transplanted Bakersfield cactus clumps from sites slated for destruction to Sand Ridge Nature Preserve and the California Living Museum in Bakersfield. Prior to construction of the East Hills Mall in Bakersfield, a few of the cactus clumps growing on the site were removed,

then were replanted in a display bed when the mall was completed. Transplanted individuals have not been monitored at any of the sites to determine survival rates or reproductive success (D. Mitchell pers. comm., R. van de Hoek pers. comm.).

Some populations of Bakersfield cactus may be protected through habitat conservation planning efforts. The Metropolitan Bakersfield Habitat Conservation Plan identifies sites in the Kern Bluff, Highway 178-Highway 184, and Oildale areas as targets for preserve acquisition. The target areas comprise 1,943 hectares (4,800 acres), but final sizes and locations of preserves will depend on the amount of funding available and the willingness of landowners to sell their property (Metropolitan Bakersfield Habitat Conservation Plan Steering Committee in litt. 1994). Kern County also is preparing a Habitat Conservation Plan, which likely will include provisions for protection of additional Bakersfield cactus populations through management agreements, conservation easements, and land acquisition (T. James A Habitat Conservation Plan in pers. comm.). preparation by California Department of Water Resources will address conservation of Bakersfield cactus and other species in the California Aqueduct rightof-way (K. Brown pers. comm.).

6. Recovery Strategy

Due to social and economic considerations, Bakersfield cactus can never again be expected to occur over large expanses of the Valley floor, as it did historically. Instead, the recovery goal is to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the taxon and in a variety of appropriate natural communities. The remaining populations occur in areas sufficiently representative of the former range to achieve this goal, but very little additional loss can be accommodated without compromising the long-term existence of the taxon. Thus, habitat protection is an essential action to prevent the extinction or irreversible decline of Bakersfield cactus. Unoccupied habitat within metapopulations also should be protected to facilitate movement of pollinators and seed dispersers. additional element of the strategy is to avoid fragmenting the few large metapopulations that remain (i.e., Caliente Creek, Comanche Point, Kern Bluff, Sand Ridge, and Wheeler Ridge) into more than 2 blocks of contiguous, protected natural land each. Land in the other target areas should be protected in blocks of at least 16 hectares (40

acres), and preferably in blocks of 65 hectares (160 acres) or more. The block size is smaller for Bakersfield cactus than for other listed plant species not for biological reasons, but because many of the areas already are so fragmented by development that larger blocks do not exist. Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion. Surveys will be necessary to determine the size of natural populations in several of the target areas and the amount of existing occupied habitat. Transplantation of Bakersfield cactus is not a viable substitute for on-site protection. However, where development would destroy entire populations, as many of the clumps as possible should be transplanted to protected areas to salvage potentially unique genetic material, and the transplants should be monitored periodically to determine survival rates and reproductive success.

Demographic studies and matrix projection modeling will be necessary to identify vulnerable stages in the life cycle. Research then will be necessary to determine how to overcome factors that are identified as limiting to population growth. Because demographic research will take several years to complete and exotic plant competition seems to be detrimental to cactus in several ways, preliminary studies should begin immediately to test the hypothesis that exotic plants are contributing to mortality of Bakersfield cactus. A biosystematic study would determine whether Bakersfield cactus should be recognized as a full species.

G. ARID GRASSLAND AND SHRUBLAND PLANTS

1. Lesser Saltscale (Atriplex minuscula)

Taxonomy.—Lesser saltscale is a member of the goosefoot family (Chenopodiaceae). Standley published the name *Atriplex minuscula* in 1916. The name was not widely accepted, and for many years lesser saltscale was considered to be merely a variant of Parish's brittlescale (*A. parishii*) that did not warrant recognition (Abrams 1944, Munz and Keck 1959). However, Taylor and Wilken (1993) considered lesser saltscale to be a valid species and have returned to using the name *A. minuscula*.

Description.—Lesser saltscale has many upright, reddish stems up to 40 centimeters (16 inches) tall. The leaves are egg-shaped with entire (untoothed) margins and typically are opposite on the upper branches and alternate on the lower part of the stem. The individual flowers of all Atriplex species are inconspicuous because they are tiny and have no petals; moreover, the male and female structures are produced in separate flowers. In lesser saltscale, both flower genders occur in the leaf axils (the points where leaves are attached to the stem), with the male flowers on the upper part of the stem and the females near the base of the same plant (Munz and Keck 1959). Each fruit consists of a single reddish seed that is enclosed by two egg- to diamond-shaped bracts, which are covered with tubercles (wart-like projections). The closely-related species brittlescale (Atriplex depressa) and Parish's brittlescale have stems and branches that lie close to the ground, unlike the erect stems of lesser saltscale, and differ in bract characters (Taylor and Wilken 1993).

Historical Distribution.—Herbarium specimens of lesser saltscale were collected historically only at Goshen (Tulare County) in 1905 and El Nido (Merced County) in 1936 (CDFG 1995).

Current Distribution.—Neither of the historical sites has been checked to determine if lesser saltscale remains extant, though no significant patch of natural land exists in either area. In 1993, lesser saltscale was discovered at 5 new localities in the San Joaquin and Sacramento Valleys (Figure 17). The southernmost report was from Kern County, near the intersection of Interstate 5 and state Highway 58, and the northernmost was at Gray Lodge Wildlife Area in Butte County (CDFG 1995). Lesser saltscale also was reported from the Kerman Ecological Reserve in Fresno County (CDFG 1995), San Luis Island in Merced County (D. Taylor pers. comm.), and along the Fresno River in Madera County (D. Mitchell pers. comm.).

Life History and Habitat.—The life history of lesser saltscale is poorly known, except that it is an annual and flowers from May to October (Skinner and Pavlik 1994). Lesser saltscale grows on sandy soils in alkaline areas at elevations of less than 100 meters (330 feet), often in association with slough systems and river floodplains. However, it is found only in microhabitats that are not inundated year-round. The species has been found in the Valley Sink Scrub, Valley Sacaton Grassland, and Nonnative Grassland natural communities. Lesser

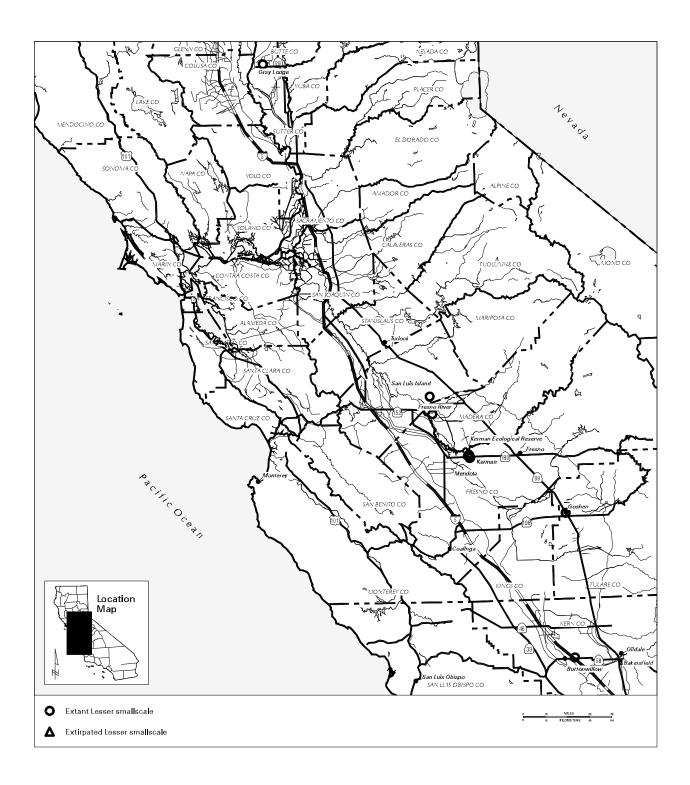


Figure 17. Distribution of lesser saltscale (Atriplex minuscula).

saltscale grows with other halophytes, including alkali sacaton, brittlescale, heartscale (*Atriplex cordulata*), and seepweed (CDFG 1995, D. Mitchell pers. comm., D. Taylor pers. comm.).

Reasons for Decline and Threats to Survival.—The lack of historical information about lesser saltscale prohibits a determination of whether or not it has declined. However, the conversion of alkali sinks to agriculture undoubtedly has reduced potential habitats (Skinner and Pavlik 1994). The extant population in Kern County is on land that is zoned for commercial development and which is for sale (CDFG 1995). The Madera County site is threatened by installation of a pipeline (D. Mitchell pers. comm.). Sites on state Wildlife Management Areas are threatened by flooding for waterfowl management (D. Taylor pers. comm.).

Conservation Efforts.—Lesser saltscale has not been the target of conservation actions. However, it may have benefited indirectly from land acquisition for other species, such as the Tipton kangaroo rat. Lesser saltscale could occur on USBLM lands in alkali sink areas (USBLM in litt. 1993) or on CDFG's Buttonwillow Preserve, which is near the known Kern County site and which includes similar habitat.

Conservation Strategy.—To ensure the long-term conservation of lesser saltscale, the strategy is to protect at least 5 populations representing the full geographic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. The highest-priority tasks for lesser saltscale are to survey historical sites and suitable habitat and to protect extant populations from development and other threats. All remaining unconverted alkali sinks in the Central Valley should be surveyed, and threats to any populations that are found must be evaluated. Surveys for lesser saltscale can be conducted concurrently with those for other rare plants that occur in alkali sinks, particularly palmate-bracted bird's-beak. Landowner cooperation is necessary to ensure protection on private lands, and the cooperation of public agencies is crucial on lands under their control. Moreover, threats must be alleviated in protected areas to ensure the continued survival of the species, and monitoring will be required to verify that populations are remaining stable. Seeds should be salvaged from any populations that are scheduled to be destroyed by development.

surveys have been completed, or at a maximum within 5 years of recovery plan approval, the status of lesser saltscale should be reevaluated.

2. Bakersfield Smallscale (Atriplex tularensis)

Taxonomy.—Bakersfield smallscale was named Atriplex tularensis by Coville in 1893 (Skinner and Pavlik 1994). The type specimen was collected 25 kilometers (15 miles) south of Bakersfield on the Tulare Plains of Kern County (Twisselmann 1967). In 1914, Jepson reduced Bakersfield smallscale to a variety of A. cordulata, but Hall and Clements regarded it as a full species in their 1923 publication. The scientific name Obione tularensis was published by Engler and Prantl in 1934 (Niehaus in litt. 1977) but was not widely accepted. Taylor and Wilken (1993) used the scientific name Atriplex tularensis for Bakersfield smallscale.

Description.—In many respects, this species is similar to lesser saltscale because both are annual members of the same genus. However, Bakersfield smallscale has stems up to 80 centimeters (30 inches) tall, has only a few stiff branches, and the leaves may be narrower in proportion to their length (Figure 18). In Bakersfield smallscale, both male and female flowers occur in leaf axils throughout the plant, and the fruits are enclosed in diamond-shaped bracts that are smooth on the surface but toothed on the margin. Bractscale (A. serenana) is a related species that overlaps in range with Bakersfield smallscale. However, unlike Bakersfield smallscale, bractscale has toothed leaf margins, the male flowers occur only at the branch tips, and the fruiting bracts are wedge-shaped or round (Munz and Keck 1959, Freas and Murphy 1988, Taylor and Wilken 1993).

Historical Distribution.—Bakersfield smallscale was restricted historically to a small area of south-central Kern County between Greenfield and Mettler (Twisselmann 1969, Skinner and Pavlik 1994, CDFG 1995 Niehaus in litt. 1977). Collection localities were Greenfield, Adobe Station, Adobe Road, and Highway 223 (CDFG 1995).

Current Distribution.—The only site that still may support Bakersfield smallscale is a remnant of Kern Lake known as Gator Pond, formerly the Kern Lake Preserve (Figure 19). However, Bakersfield smallscale specimens

collected in the area historically differ in appearance from those now present at Gator Pond (D. Taylor pers. comm.).

Life History and Habitat.—Bakersfield smallscale is a summer annual, germinating from May to June and flowering from June to October (Freas and Murphy 1991, Skinner and Pavlik 1994). Surface soil moisture is required during the summer and fall months for seed germination and seedling survival (Freas and Murphy 1988, Bowen in litt. 1986). The population at Gator Pond declined from 721 plants in 1985 to 13 in 1987 and 0 in 1992 as a result of a prolonged drought (Tollefson in litt. 1992). Other aspects of the life history and reproductive biology are unknown.

All the populations of Bakersfield smallscale were found on the subalkaline margins of alkali sinks at elevations of 91 to 96 meters (300 to 315 feet). Associated species included alkali heath, glasswort, scratchgrass (*Muhlenbergia asperifolia*), and saltgrass (Twisselmann 1969, CDFG 1995, Bowen in litt. 1986). Other species of concern that occur at Kern Lake are hispid bird's-beak and Buena Vista Lake shrew. Comanche Point layia occurred in the vicinity historically (CDFG 1995).

Reasons for Decline and Threats to Survival.—Like many of the other endangered plants of the San Joaquin Valley, the decline of Bakersfield smallscale was due

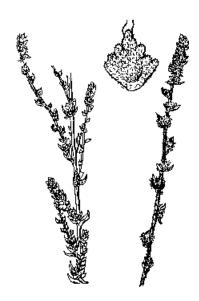


Figure 18. Illustration of Bakersfield smallscale (from Abrams 1994, with permission).

primarily to agricultural activities (Skinner and Pavlik 1994, CDFG 1995). At most of the historical locations of Bakersfield smallscale, the habitat was completely destroyed by cultivation. At Gator Pond the soil surface was not disturbed, but the hydrology was altered by lowering the water table in the vicinity, leading to conditions too dry for germination and survival of Bakersfield smallscale in all but the wettest years (Bowen in litt. 1986, Tollefson in litt. 1992).

The *Atriplex* that now occurs at Gator Pond exhibits characteristics intermediate between Bakersfield smallscale and bractscale. Freas and Murphy (1988) speculated that under the drier conditions, bractscale increased and the two species hybridized. Thus, pure Bakersfield smallscale may be extinct. Even if the two species did not hybridize, the plants at Gator Pond may represent an undescribed form of bractscale (Skinner and Pavlik 1994, Skinner et al. 1995). Another possibility is that Bakersfield smallscale never was a distinct species, but instead was an environmental variant of bractscale that appeared only in years of high rainfall, when soil salinity decreased (Freas and Murphy 1988).

The greatest threat to the continued survival of the annual *Atriplex* at Gator Pond is conversion to agriculture. The landowner, J. G. Boswell Company, formerly leased the site to The Nature Conservancy as the Kern Lake Preserve, but the lease was not renewed in 1995 (R. Tollefson pers. comm.). Even if the J. G. Boswell Company chooses not to farm the land, the lack of sufficient water to the site threatens the continued existence of the plants.

Conservation Efforts.—Bakersfield smallscale was state-listed as endangered in 1987. During the period when The Nature Conservancy managed the Kern Lake Preserve, the Bakersfield smallscale population was monitored annually. When the population declined precipitously, The Nature Conservancy contracted Stanford University's Center for Conservation Biology to study the reasons for the decline. They began greenhouse propagation of plants in 1987, along with research on the site requirements and taxonomy of Bakersfield smallscale (Freas and Murphy 1988). Additional water was provided to the Gator Pond population in 1991. The potential for hydrologic restoration of the site is being studied (K. Freas pers. comm.), and USFWS is negotiating with the J.G. Boswell Company to protect the site (Medlin in litt. 1995a). The Kern County Valley Floor Habitat

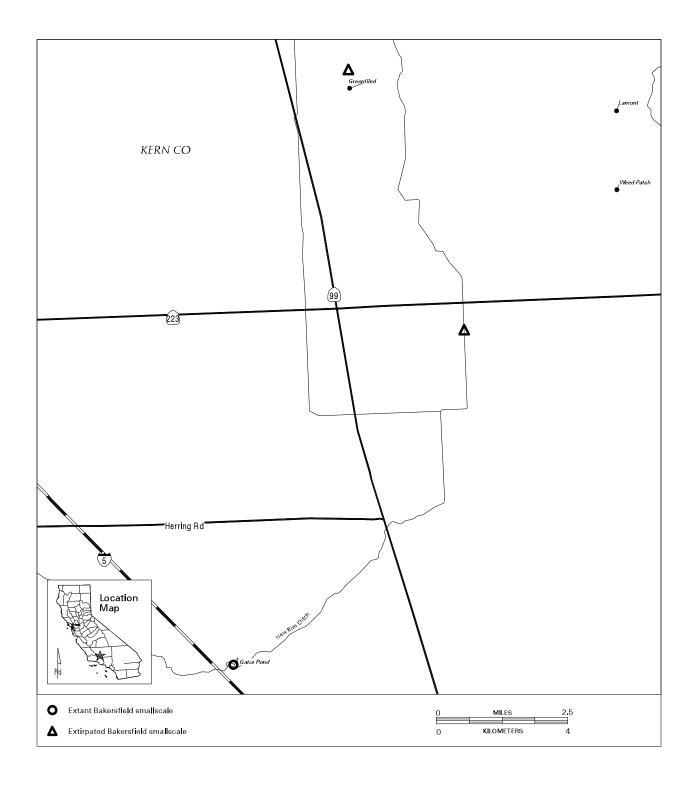


Figure 19. Distribution of Bakersfield smallscale (Atriplex tularensis).

Conservation Plan is expected to provide incentives for protecting the Gator Pond area (T. James pers. comm.).

Conservation Strategy.—The conservation strategy for Bakersfield smallscale is similar to that for lesser saltscale: to protect at least 5 distinct populations numbering at least 1,000 individuals on natural land in blocks of at least 65 hectares (160 acres), with appropriate site management to ensure the continued existence of the species. To accomplish this goal, at least 4 additional populations must be discovered or established through artificial means, and the Gator Pond population must be increased substantially. Due to the precarious situation at the single known location, all recovery actions for Bakersfield smallscale are high priority. First, Gator Pond must be protected from conversion to other uses, either through a perpetual conservation easement or through transfer of fee title to a conservation entity. Hydrologic restoration of the site also is imperative. These actions also will further conservation of the Buena Vista Lake shrew and hispid bird's-beak. Surveys for Bakersfield smallscale should be conducted in the remaining alkali sink areas of Kern County, particularly in years with higher than normal precipitation. However, so little suitable habitat remains in the historic range of the species that 4 additional populations are not likely to be found during surveys.

Taxonomic studies and research into the effect of soil salinity on morphology (Freas and Murphy 1988) should Also, genetic comparisons should be continue. attempted between Gator Pond plants, bractscale, and related species to determine whether hybridization is possible (D. Taylor pers. comm.). Greenhouse propagation of the Gator Pond plants should continue, and seeds should be collected from any additional populations that are found. When definite Bakersfield smallscale populations are identified (at Gator Pond or elsewhere), introductions to protected alkali sinks in Kern County should begin immediately to bring the total number of sites to 5. The status of Bakersfield smallscale should be reevaluated within 5 years of recovery plan approval.

3. Lost Hills Saltbush (Atriplex vallicola)

Taxonomy.—Lost Hills saltbush has retained the scientific name *Atriplex vallicola* since Hoover (1938) first described it. However, according to Taylor and

Wilken (1993) a more appropriate rank for Lost Hills saltbush may be as a subspecies of crownscale (*A. coronata*). Another common name for *A. vallicola* is Lost Hills crownscale (Taylor and Wilken 1993). The type locality for Lost Hills saltbush is 8 kilometers (5 miles) north of the Lost Hills oil field, in Kern County (Hoover 1938). Plants from the Carrizo Plain may represent an undescribed subspecies of *A. vallicola* (Taylor and Wilken 1993, Skinner and Pavlik 1994).

Description.—Lost Hills saltbush reaches a maximum height of only 20 centimeters (8 inches). The male and female flowers are mixed in small clusters in the upper leaf axils. The fruiting bracts are broadly triangular, irregularly toothed, and may or may not have tubercles. Lost Hills saltbush differs from crownscale primarily in the shape and size of the bracts (Hoover 1938, Taylor and Wilken 1993).

Historical Distribution.—Prior to 1980, Lost Hills saltbush was reported from three general areas: north of Lost Hills (CDFG 1995), Mendota in Fresno County (Hoover 1938), and the Carrizo Plain in San Luis Obispo County (Hoover 1970).

Current Distribution.—In the 1980s, a number of additional sites were discovered, and the species was confirmed to be extant near Lost Hills and on the Carrizo Plain (Figure 20). The centers of concentration currently known are: (1) Lost Hills to extreme southern Kings County; (2) the Kerman Ecological Reserve in Fresno County; (3) the Soda Lake region of the Carrizo Plain; (4) the Lokern- McKittrick area of Kern County; and (5) southwestern Merced County (Olson and Magney 1992, Skinner and Pavlik 1994, CDFG 1995). The Lost Hills and Carrizo Plain centers of concentration represent large (greater than 10,000 plants) metapopulations, but most other sites had only a few hundred individuals or fewer in 1993 (CDFG 1995).

Life History and Habitat.—Lost Hills saltbush is an annual that flowers from May to August (Skinner and Pavlik 1994). Other aspects of its life history have not been studied. This species occurs in the Valley Sink Scrub, Valley Saltbush Scrub, Nonnative Grassland, and Alkali Meadow natural communities. At most sites, Lost Hills saltbush grows in the dried beds of alkaline pools, but one population south of McKittrick occurs on exposed slopes rich in gypsum. Associated species include common saltbush, spiny saltbush, alkali heath, saltgrass, and seepweed. Valley-floor populations occur at elevations of 50 to 85 meters (165 to 280 feet), whereas

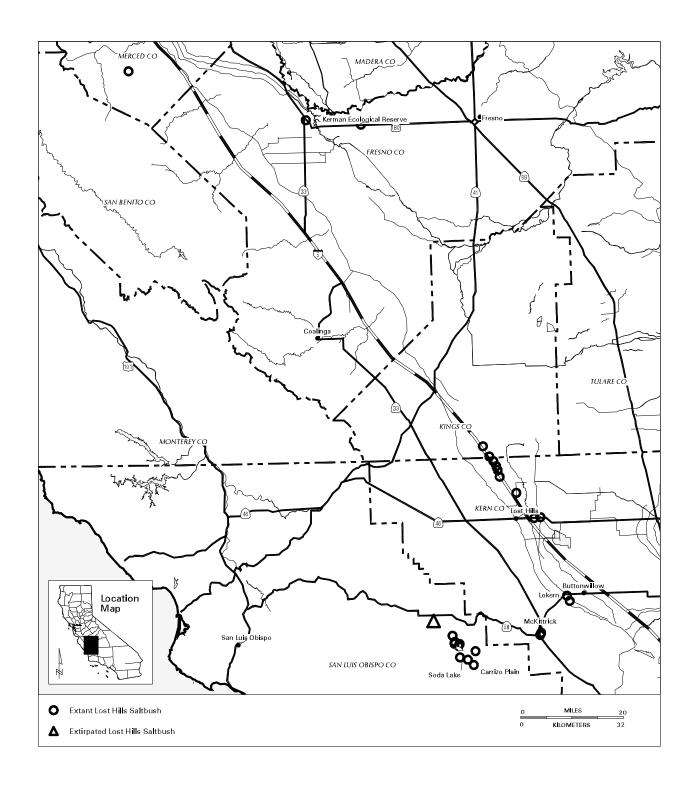


Figure 20. Distribution of Lost Hills saltbush (Atriplex vallicola).

those on the Carrizo Plain and south of McKittrick range from approximately 400 to 600 meters (1,300 to 2,000 feet) in elevation (Hoover 1938, Olson and Magney 1992, CDFG 1995, California Native Plant Society in litt. 1988*a*).

Reasons for Decline and Threats to Survival.—Two occurrences of Lost Hills saltbush, one near Lost Hills and one on the Carrizo Plain, were eliminated by agricultural conversion. Trampling by livestock degraded habitat for this species at several sites. One of the largest occurrences (near Soda Lake) is on private land that has been partially cleared for a mobile home. Currently, the Lost Hills center of concentration is in the greatest danger of elimination; it is on private land in an area valuable for commercial development and agriculture. In addition, flooding for waterfowl management poses a threat in the vicinity of Lost Hills. The population south of McKittrick faces potential threats from petroleum production, off-road vehicle activity, and the installation and maintenance of an electric transmission line (Skinner and Pavlik 1994, CDFG 1995, California Native Plant Society in litt. 1988a).

Conservation Efforts.—Although Lost Hills saltbush has not been the subject of direct conservation efforts, it has benefited indirectly from acquisition directed at other species. Much of the land around Soda Lake has been purchased by USBLM as part of the Carrizo Plain Natural Area. Soda Lake has been proposed as part of the Carrizo Area of Critical Environmental Concern (USBLM in litt. 1993), and grazing is not allowed in that area currently (Doren in litt. 1993). One occurrence in Lokern now is on Center for Natural Lands Management land, and the Kerman Ecological Reserve is managed by CDFG. Additional lands in the Lost Hills and Lokern areas may be protected if the Kern County Valley Floor Habitat Conservation Plan is implemented as planned, but no specific measures are provided for the conservation of Lost Hills saltbush (T. James pers. comm.). Floristic surveys of Naval Petroleum Reserve-1 in California may reveal populations of Lost Hills saltbush in suitable habitats on the margins of Elk Hills (J. Hinshaw pers. comm.).

Conservation Strategy.—The most important task for conservation of Lost Hills saltbush is to protect existing populations on private land from ongoing threats. To do so, sites must be secured through conservation easements or acquisition, and public agencies must agree to protect habitat on lands under

their control. Lost Hills saltbush can benefit from recovery actions directed at the listed plant and animal species, many of which occur in the same areas. Surveys must also be conducted in suitable habitat. Because it is inconspicuous and difficult to identify, Lost Hills saltbush may have been overlooked, even in areas already set aside for conservation purposes. If at least 5 distinct populations representing the full geographic range of the species are protected and managed to promote the continued survival of Lost Hills saltbush, listing should not be necessary. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1.000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Taxonomic research should be done to determine the appropriate rank and affinities of Lost Hills saltbush, including the entity on the Carrizo Plain. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Lost Hills saltbush should be reevaluated.

4. Vasek's Clarkia (C. tembloriensis ssp. calientensis)

Taxonomy.—Vasek's clarkia, a member of the evening-primrose family (Onagraceae), was described originally as a full species, Clarkia calientensis (Vasek 1977). The type locality of Vasek's clarkia is "...along Caliente Road, 10 kilometers E of the junction with the Bakersfield-Tehachapi highway" (Vasek 1977, p. 252). Based on its morphological similarity to the more common Temblor clarkia (Clarkia tembloriensis), Holsinger (1985) proposed the name C. tembloriensis ssp. calientensis, which is in current use (Lewis 1993). However, biosystematic studies in progress suggest that Vasek's clarkia is a unique taxon that originated independently of Temblor clarkia in recent times (T. Holtsford pers. comm.).

Description.—Vasek's clarkia can grow up to 80 centimeters (30 inches) tall and has alternate, grayishgreen, lance-shaped leaves. The flowers have four lavender-pink petals with narrow bases and diamond-shaped tips. The *styles* (part of the female reproductive system) are approximately the same length as the stamens. Vasek's clarkia has broader petals, shorter styles, narrower fruits, and larger seeds than Temblor clarkia, and both differ from gunsight clarkia (*C. unguiculata*) in that they lack long hairs on the flower parts (Holsinger 1985, Lewis 1993).

Historical Distribution.—This taxon is endemic to the Caliente Hills of Kern County, which are southeast of Bakersfield (Skinner and Pavlik 1994). The historical distribution consisted of only the type locality, where the taxon was first collected in 1967 (Vasek 1977).

Current Distribution.—Plants have not been observed at the type locality since 1982, despite repeated searches. However, two other occurrences were discovered west of the type locality in 1982 (Figure 21); they represent a single metapopulation (CDFG 1995, T. Holtsford pers. comm.).

Life History and Habitat.—Vasek's clarkia is an annual, flowers in April (Skinner and Pavlik 1994), and is self-pollinating. The timing of seed germination in the wild is not known, but in greenhouse tests, plants that were started from seed in January had a higher reproductive output than those that were started in November (Vasek 1977). The closely-related Springville clarkia (Clarkia springvillensis) forms a persistent seed bank, and this taxon may as well (T. Holtsford pers. comm.). Vasek's clarkia grows in steep-sided canyons on grassy north- and west-facing slopes at elevations of 275 to 335 meters (900 to 1,100 feet). Associated species include bladderpod, farewell-to-spring (Clarkia cylindrica), and gunsight clarkia (CDFG 1995). The extant metapopulation comprises several thousand individuals in favorable years but has extremely low genetic variability (T. Holtsford pers. comm.).

Reasons for **Decline.**—The reason for the disappearance of Vasek's clarkia from the type locality is unknown. The other two occurrences have not declined.

Threats to Survival.—Vasek's clarkia is a very narrow endemic because of its extremely limited range, small population size, and lack of genetic variability. Thus, Vasek's clarkia is very vulnerable to extinction from random catastrophic events. All three of the reported occurrences were on private property, some of which is owned by the Tejon Ranch Company. Most of the occupied habitat is too steep to be developed or heavily grazed (T. Holtsford pers. comm.). Competition from exotic grasses is believed to be the primary threat to this taxon (T. Holtsford pers. comm.).

Conservation Efforts.—Vasek and his colleagues have conducted taxonomic and genetic research, surveyed limited areas in the Caliente Hills, and monitored Vasek's clarkia since the species was first described. However, access to the sites has been

restricted by the land owner in recent years (CDFG 1995, T. Holtsford pers. comm.). No other conservation measures have been instituted to date, but Kern County may provide incentives for conservation of the populations through the Valley Floor Habitat Conservation Plan (T. James pers. comm.).

Conservation Strategy.—Although Vasek's clarkia is a narrow endemic, at least 5 separate populations should be protected to increase the probability of longterm survival. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Conservation of Vasek's clarkia entails maintaining compatible uses at the known sites, controlling exotic grasses, surveying suitable habitats for additional populations, and banking seed as a safeguard against extinction. Conservation agreements with the private landowners are recommended, even though development is not expected in the area in the near future. Holtsford (pers. comm.) recommends continued light grazing to control grasses. Monitoring will be essential to evaluate population trends; changes in site management may be necessary if declining population trends are observed. Surveys for Vasek's clarkia could be coordinated with those for California jewelflower and Bakersfield cactus, which occurred historically in the Caliente Hills, and where potential habitat still exists. Seed collections would not need to be large to be representative of the gene pool in the extant metapopulation but should be conducted according to Center for Plant Conservation (1991) recommendations. Introduction of the subspecies outside of the known range is not recommended, but planting of seeds in nearby suitable habitats within the historic range may be necessary to achieve the required number of populations if surveys prove unsuccessful. The status of Vasek's clarkia should be reevaluated within 5 years of recovery plan approval.

5. Temblor Buckwheat (Eriogonum temblorense)

Taxonomy.—Temblor buckwheat was named *Eriogonum temblorense* by Howell and Twisselmann (1963) and is a member of the buckwheat family (Polygonaceae). The type specimen was collected by Twisselmann in Chico Martinez Canyon, in Kern County. The scientific name has remained unchanged

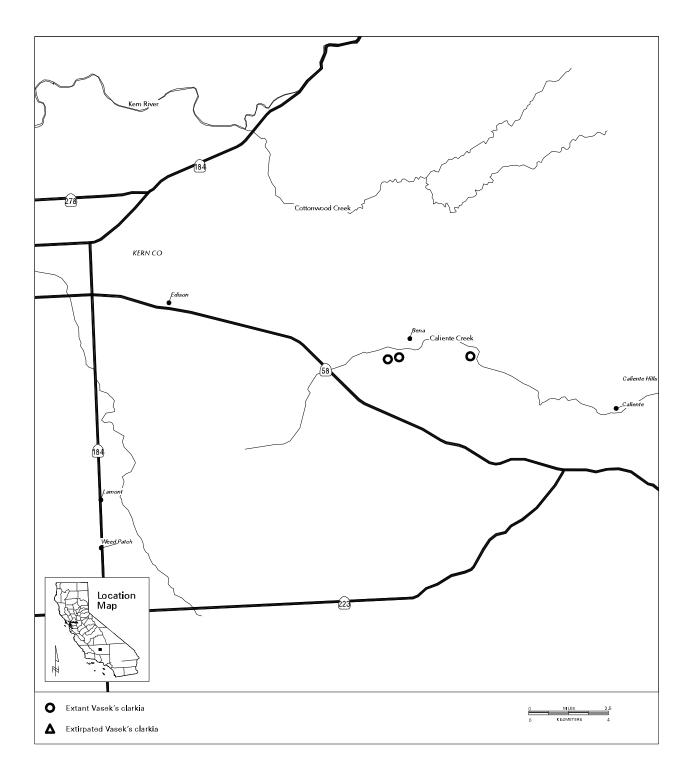


Figure 21. Distribution of Vasek's clarkia (C. tembloriensis ssp. calientensis).

since it was published, but various authors (Hoover 1970, Reveal 1989, Hickman 1993, Skinner and Pavlik 1994, Skinner et al. 1995) have speculated that Temblor buckwheat should be combined with Eastwood's buckwheat (*E. eastwoodianum*).

Description.—The height of Temblor buckwheat ranges from 10 to 80 centimeters (4 to 30 inches) and varies with precipitation. The leaves occur primarily at the base of the plant and are densely covered with matted hairs on both surfaces. The appearance of individual plants of Temblor buckwheat may vary from spring to fall, with the blades rounded early in the year and more elliptical later (Hoover 1970). The branches, which are elongated and spreading, bear flowers only at their tips, where several 2-millimeter (0.08-inch) long, white flowers are clustered inside a cup-like structure. Temblor buckwheat is differentiated from Eastwood's buckwheat and another closely related species, Idria buckwheat (E. vestitum), by the placement of the leaves and the size and surface texture of certain flower parts (Reveal 1989, Hickman 1993). However, the spring form of Temblor buckwheat closely resembles Eastwood's buckwheat (Hoover 1970).

Historical Distribution.—The range of Temblor buckwheat apparently always has been restricted. The historical distribution is based on 19 collections, which are clustered in eight areas of the inner Coast Ranges: Chico Martinez Canyon and the Shale Hills in Kern County; Indian Valley, Parkfield Grade, and Stone Canyon in Monterey County; and Polonio Pass, Cottonwood Pass, and the Shandon area in San Luis Obispo County (Twisselmann 1967, Hoover 1970, CDFG 1995).

Current Distribution.—The historical occurrences have not been revisited in recent years but are believed to be extant (Skinner and Pavlik 1994). Another center of occurrence was discovered on the Elkhorn Plain in 1995 (Figure 22).

Life History and Habitat.—Temblor buckwheat is an annual, but it differs from most annuals of the San Joaquin Valley in that it flowers during the hottest part of the year, from May through September (Twisselmann 1967, Reveal 1989, Skinner and Pavlik 1994). Other aspects of its life history have not been investigated. Temblor buckwheat typically occurs on white, shattered shale (Twisselmann 1967, R. Lewis pers. comm.) and occasionally on sandstone (Hickman 1993). The shale areas are dry and nearly barren of other vegetation, but

California buckwheat (*Eriogonum fasciculatum*), sun cups (*Camissonia californica*), and Booth's evening-primrose (*C. boothii*) may be present (Lewis in litt. 1995, D. Taylor pers. comm.). The type locality was characterized by saltbush scrub (CDFG unprocessed data). All reported sites for Temblor buckwheat are below 1,000 meters (3,300 feet) in elevation (Hickman 1993). The Elkhorn Plain metapopulation occurs on slopes of 0 to 25 percent (Lewis in litt. 1995).

Reasons for Decline and Threats to Survival.— The current status of Temblor buckwheat is unknown because threats have not been evaluated at the historical locations. The Elkhorn Plain metapopulation occurs on USBLM land that is protected as an Area of Critical Environmental Concern (USBLM in litt. 1993). Only one minor threat was noted by Lewis on the Elkhorn Plain (in litt. 1995): some plants were trampled by cattle in the vicinity of a water trough. The other historical localities are on private property in areas that currently are not desirable for development.

Conservation Efforts.—Russ Lewis (pers. comm.) of USBLM conducted surveys for Temblor buckwheat in potential habitats of the southern Caliente Range, southern Temblor Range (south of Crocker Grade), and the Maricopa area in 1995. He found the species only on the Elkhorn Plain. Temblor buckwheat possibly could occur on USBLM's proposed Chico Martinez Area of Critical Environmental Concern (USBLM in litt. 1993), but surveys would be necessary to verify the presence of the species there.

Conservation Strategy.—To ensure the long-term conservation of Temblor buckwheat, the strategy is to protect at least 5 populations representing the full geographic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Historical locations of Temblor buckwheat should be surveyed to verify whether the species still persists, to evaluate threats, and to obtain population estimates. Periodic monitoring of the populations is recommended, particularly on the Elkhorn Plain due to the potential impacts of cattle trampling. Current management should be continued in all areas where the species is found; if the populations decrease in favorable years, changes in management may be necessary. Biosystematic studies would be valuable to establish the relationship of plants in this complex (Skinner et al. 1995), but this task is of low priority.

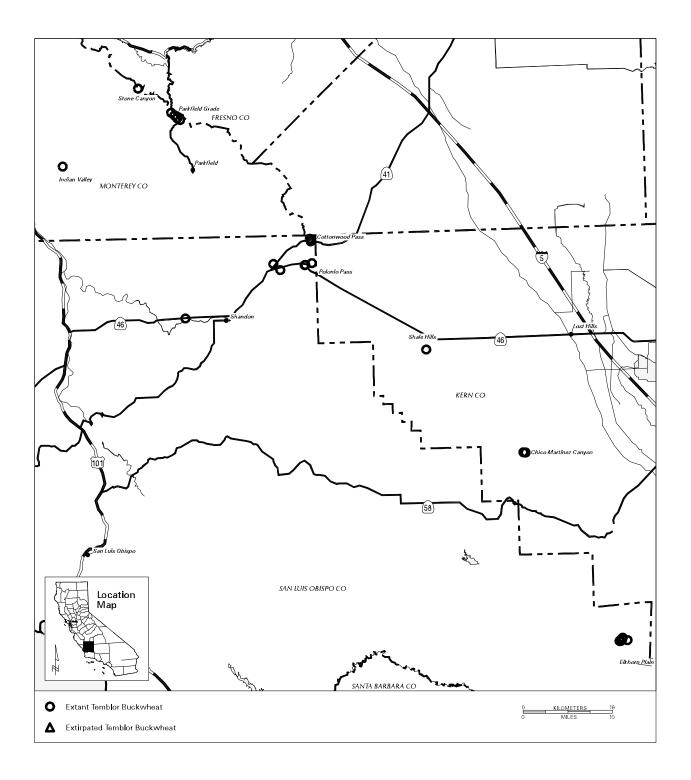


Figure 22. Distribution of Temblor buckwheat (Eriogonum temblorense).

When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Temblor buckwheat should be reevaluated.

6. Tejon Poppy (Eschscholzia lemmonii ssp. kernensis)

Taxonomy.—Both this taxon and the next are members of the poppy family (Papaveraceae). Tejon poppy was initially given the name *Eschscholzia caespitosa* ssp. *kernensis* based on a specimen from the "Tejon Hills, 2 miles northwest of Tejon Ranch headquarters, Kern County" (Munz 1958, p. 91). However, Tejon poppy has more characters in common with Lemmon's poppy (*Eschscholzia lemmonii* ssp. *lemmonii*) than with tufted poppy (*Eschscholzia caespitosa*), and thus Clark (1986) renamed Tejon poppy *E. lemmonii* ssp. *kernensis*.

Description.—Tejon poppy reaches a maximum height of 30 centimeters (12 inches). The deeply-divided leaves are mostly clustered at the base of the plant (Figure 23). Each flowering stem is taller than the leaves and bears a single erect, hairless bud that develops into a showy, orange flower. Tejon poppy lacks a rim-like appendage below the flower. The fruit is elongated and contains many tiny, rough seeds. Unlike Tejon poppy, Lemmon's poppy has nodding, hairy buds and California poppy (*E. californica*) has a conspicuous, flared rim beneath the flower. Tufted poppy has smaller, yellow flowers and smoother seeds (Munz and Keck 1959, Clark 1986, 1993).

Historical Distribution.—Tejon poppy is restricted to Kern County. Based on literature reports and collections, the taxon occurred historically in six areas in the low hills that surround the southern tip of the San Joaquin Valley (Figure 24). Twisselmann (1967) noted that in the Tejon Hills, this taxon occurred between Chanac and Tejon Canyons. Other historical locations were Dry Bog Knoll in Adobe Canyon (between Bakersfield and Woody), "mesas east of Bakersfield" (Twisselmann 1967, p. 240), Comanche Point (Twisselmann 1969), Elk Hills, Pleito Hills (CDFG 1995), and near Maricopa (Skinner and Pavlik 1994).

Current Distribution.—The current distribution of Tejon poppy is not known because it has not been reported since 1969.

Life History and Habitat.—This annual herb flowers from March to April (Skinner and Pavlik 1994). Details of the life history are not known, but Tejon poppy populations are conspicuous only in years of above-average precipitation (Twisselmann 1967). Tejon poppy grows on adobe clay soils in sparsely-vegetated grasslands between 250 and 600 meters (800 and 2,000 feet) in elevation (Munz and Keck 1959, Twisselmann 1967, 1969, CDFG 1995). At Comanche Point, Tejon poppy was observed in association with Kern brodiaea (Brodiaea terrestris ssp. kernensis), Sunset lupine (Lupinus microcarpus var. horizontalis), and Comanche Point layia (Twisselmann 1969).

Reasons for Decline.—Tejon poppy has always been rare by virtue of its restricted range and soil affinities. Twisselmann (1967, p. 240) described it as "normally scarce." Except for Elk Hills, all the areas in which it occurred are on private land, but none have been subject to urban or industrial development.

Threats to Survival.—Potential threats to Tejon poppy include competition from exotic plants, overgrazing (Skinner and Pavlik 1994), and future residential development.

Conservation Efforts.—This taxon has not been the focus of conservation measures, nor have any of the historical areas of occurrence been protected for other rare species. However, U.S. Department of Energy is

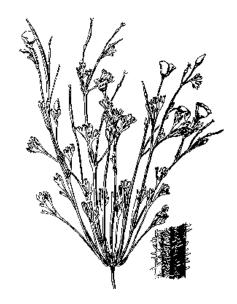


Figure 23. Illustration of Tejon poppy (from Abrams 1944, with permission).

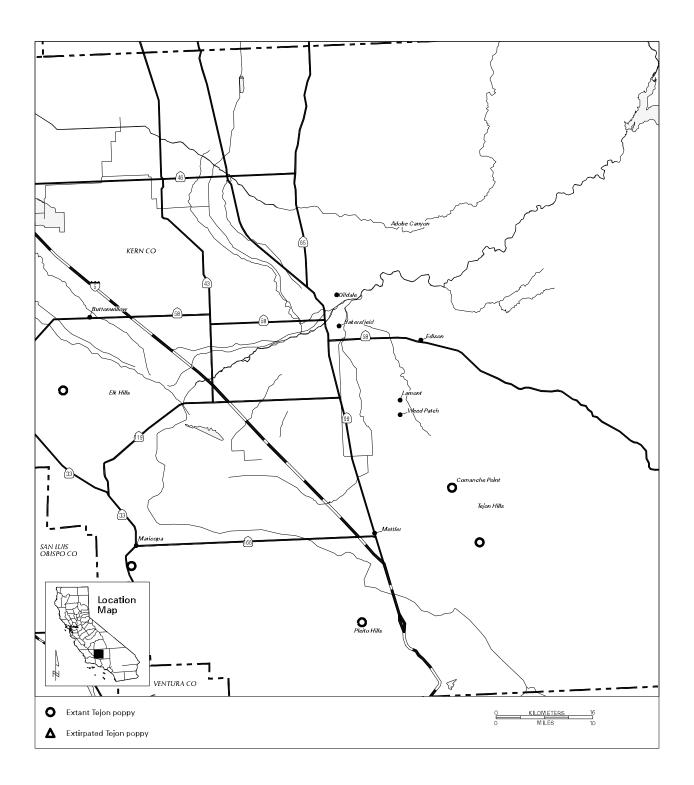


Figure 24. Distribution of Tejon poppy (Eschscholzia lemmonii ssp. kernensis).

sponsoring floristic surveys of Naval Petroleum Reserve-1 in California that may lead to the rediscovery of the historic Elk Hills occurrence of Tejon poppy or identification of additional populations in the area (J. Hinshaw pers. comm.).

Conservation Strategy.—To ensure the long-term conservation of Tejon poppy, the strategy is to protect at least 5 populations representing the full geographic range of the taxon. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Historical locations for Tejon poppy must be searched to determine if the subspecies is extant and what site-specific threats it may face. Any extant populations should be protected from identified threats. If Tejon poppy remains extant at Comanche Point, it could be protected in conjunction with Bakersfield cactus and Comanche Point layia. Monitoring is necessary to determine whether the populations are self-sustaining. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Tejon poppy should be reevaluated.

7. Diamond-petaled California Poppy (Eschscholzia rhombipetala)

Taxonomy.— The scientific name of this species, *Eschscholzia rhombipetala*, was published by Greene in 1885 (Abrams 1923). Jepson later reduced it to a subspecies of tufted poppy, assigning the name *E. caespitosa* var. *rhombipetala* (Munz and Keck 1959). Currently, the name *E. rhombipetala* is in use (Clark 1993).

Description.—Diamond-petaled California poppy resembles Tejon poppy and Lemmon's poppy in many respects. However, diamond-petaled California poppy may have erect or nodding buds, the flowers are small and yellow, and the bases of the leaves are fleshy (Hoover 1970, Clark 1993, Clark in litt. 1979). The fruits of diamond-petaled California poppy are conspicuous because they are 4 to 7 centimeters (1.5 to 3 inches) long, which may nearly equal the height of the plants (Hoover 1970). Diamond-petaled California poppy is distinguished from frying pans (*E. lobbii*), another poppy that occurs in the same general area, by leaf position and seed characteristics (Clark 1993).

Historical Distribution.—Diamond-petaled California poppy was known historically from seven sites in the inner Coast Ranges (Figure 25): Corral Hollow in Alameda County; Stites in Colusa County; Antioch and the hills south of Byron in Contra Costa County; the La Panza area and near Yeguas Creek in San Luis Obispo County; and Del Puerto Canyon in Stanislaus County (Hoover 1970, Clark 1993, CDFG 1995, Clark in litt. 1979, Bittman in litt. 1986b). Hoover (1970) mentioned that the species occurred in San Joaquin County, but no specimens remain to document his report (Skinner and Pavlik 1994).

Current Distribution.—One population of diamond-petaled California poppy was discovered in 1997 on Lawrence Livermore Laboratory property in Alameda County (T. Kato pers. comm.). No other populations have been observed since 1950 (Skinner and Pavlik 1994, Skinner et al. 1995).

Life History and Habitat.—Diamond-petaled California poppy has been seen so infrequently that little is known about the species. Flowering specimens were collected in March and April. Near La Panza, diamond-petaled California poppy was found on nearly barren areas of clay soils in association with San Benito thornmint (Acanthomintha obovata) and large-leaved filaree (Erodium macrophyllum) (Hoover 1970, Bittman in litt. 1986b). Clark (1993) indicated that diamond-petaled California poppy has been found in fallow fields. The historical sites were found at 9 to 1,000 meters (30 to 3,300 feet) in elevation (CDFG 1995).

Reasons for Decline and Threats to Survival.—California Native Plant Society had classified diamond-petaled California poppy as extinct (Skinner and Pavlik 1994, Skinner et al. 1995). Natural land remains in most of the areas where it was collected historically. Some land in the vicinity of Yeguas Creek has been converted to agriculture, and the La Panza area is subject to heavy grazing (CDFG 1995, Bittman in litt. 1986b). The Antioch area is growing rapidly and thus is subject to development.

Conservation Efforts.—Four of the historical locations of diamond-petaled California poppy have been surveyed over the past 30 years without success. Searches in the La Panza area in 1991 revealed only Lemmon's poppy (CDFG 1995).

Conservation Strategy.—The conservation strategy

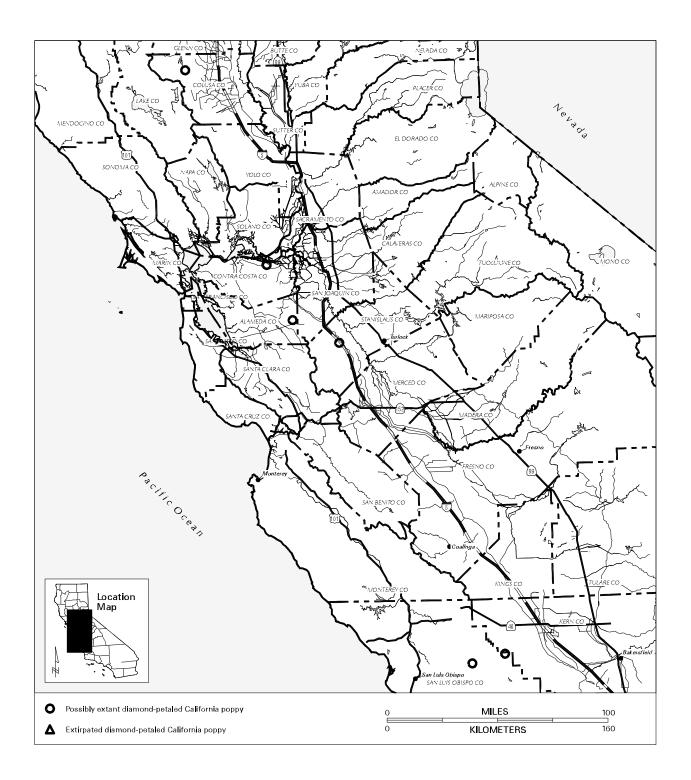


Figure 25. Distribution of diamond-petaled California poppy (Eschscholzia rhombipetala).

for diamond-petaled California poppy is to protect the Lawrence Livermore Laboratory population and at least 4 other populations representing the full historic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1.000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Considering that suitable habitat remains at many of the historical sites, efforts to rediscover diamond-petaled California poppy should continue, particularly in years of above-average rainfall. additional populations are discovered during surveys, threats must be determined on a site-by-site basis. Changes in site uses are not necessary unless impacts to the population are noted. Monitoring should be initiated as soon as occurrences are found. If additional populations are found but fewer than 5 populations can be protected, seed collection (Center for Plant Conservation 1991) and introduction to public lands will be necessary to ensure the continued existence of the species. The status of diamond-petaled California poppy should be reevaluated within 5 years of recovery plan approval or when surveys have been completed, whichever is less.

8. Comanche Point Layia (Layia leucopappa)

Taxonomy.—Keck (1935) gave Comanche Point layia the name *Layia leucopappa*. The common name refers to the type locality in Kern County, where this species was first collected in 1927. The original scientific name is still in use (Baldwin and Bainbridge 1993). Comanche Point layia is a member of the aster family.

Description.—Comanche Point layia (Figure 26) has glandular stems that grow up to 60 centimeters (24 inches) tall. The leaves are oblong, fleshy, and entire to lobed. Each daisy-like flower head is composed of two kinds of tiny flowers: ray florets have flattened corollas and occur near the margin of the head, whereas disk florets are tubular and are clustered in the center of the head. Comanche Point layia has 6 to 15 white ray florets and 20 to 100 yellow disk florets. The achenes produced by the ray and disk florets differ slightly. Comanche Point layia is distinguished from other members of the genus that have white ray flowers by the fleshy leaves and microscopic characters of the flower head and

achenes (Munz and Keck 1959, Abrams and Ferris 1960, Baldwin and Bainbridge 1993).

Historical Distribution.—Comanche Point layia is endemic to Kern County. It occurred historically in three general areas of the extreme southern San Joaquin Valley and adjacent hills to the east (Figure 27): (1) the Comanche and Tejon Hills (including the type locality), (2) between Edison and Bena, and (3) on the Valley floor near the southern end of Kern Lake (Twisselmann 1967, 1969, CDFG 1995).

Current Distribution.—Comanche Point layia remains in the Comanche and Tejon Hills but has not been observed in the Edison-Bena area or on the Valley floor since 1935 (CDFG 1995).

Life History and Habitat.—The typical flowering period for Comanche Point layia, an annual, is March to April (Munz and Keck 1959). However, it has been observed only in years of higher than average rainfall (Twisselmann 1967, 1969). Cross-pollination is necessary for seed set (Munz and Keck 1959). In the Comanche and Tejon Hills, Comanche Point layia grows on sparsely-vegetated microhabitats in Nonnative Grassland. Associated species include annual buckwheats (Eriogonum spp.), hollisteria (Hollisteria lanata), leafystemmed coreopsis (Coreopsis calliopsidea), and Tejon poppy. On the Valley floor, Comanche Point layia was found on the margins of alkali sinks and on hummocks. Comanche Point layia typically occurs on light-colored, subalkaline clay soils at elevations of 150 to 350 meters



Figure 26. Illustration of Comanche Point layia (from Abrams and Ferris 1960, with permission).

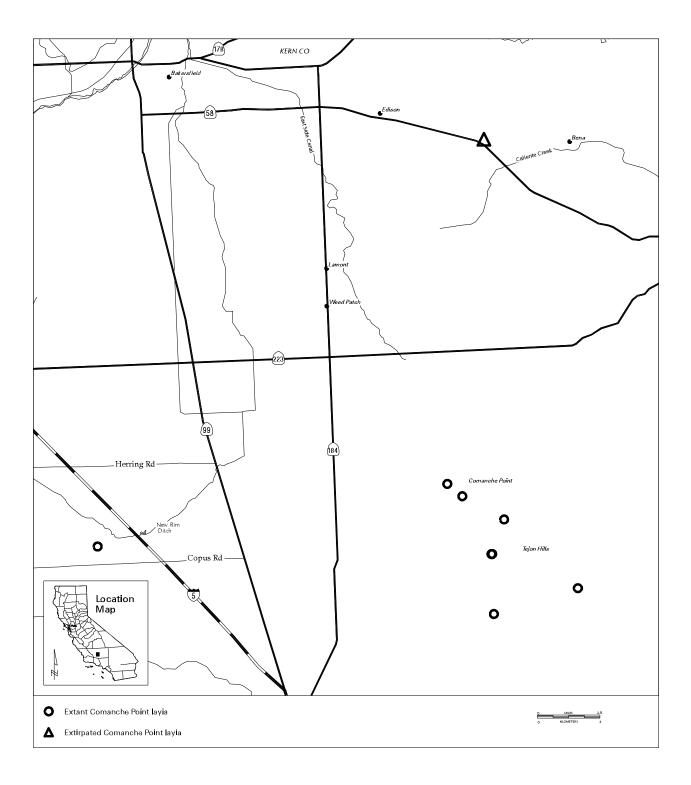


Figure 27. Distribution of Comanche Point layia (Layia leucopappa).

(500 to 1,150 feet) (Twisselmann 1967, 1969, Baldwin and Bainbridge 1993, CDFG 1995).

Reasons for Decline and Threats to Survival.—The formerly extensive occurrences of Comanche Point layia on the Valley floor apparently have been eliminated by conversion to agriculture (Twisselmann 1967, 1969, CDFG 1995). Populations in the Comanche and Tejon Hills potentially are threatened by urban development and are subject to grazing (Skinner and Pavlik 1994).

Conservation Efforts.—Comanche Point layia has not received any formal protection. Conservation needs of the species are being considered during the development of the Kern County Valley Floor Habitat Conservation Plan (T. James pers. comm.).

Conservation Strategy.—To ensure long-term conservation of Comanche Point layia, the strategy is to protect at least 5 populations representing the full historic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. The highest-priority task to recover Comanche Point layia is to ensure that the extant populations are protected from development. Comanche Point layia could be protected jointly with Bakersfield cactus and Tejon poppy at Comanche Point if the appropriate microhabitats are included in a conservation area. Monitoring of the populations is necessary to determine if they are self-sustaining. If populations do not decline, changes in land use are not necessary. Surveys for Comanche Point layia are also important in alkali sinks and can be conducted concurrently with those for Bakersfield smallscale and other halophytes. Comanche Point layia also may be rediscovered during surveys for Bakersfield cactus, California jewelflower, Vasek's clarkia, and Tejon poppy in the Comanche and Bena Hills. Collection of a representative seed sample (Center for Plant Conservation 1991) from the Comanche-Tejon Hills metapopulation and any discovered in disjunct areas is recommended to preserve genetic material because the distribution of this species is so limited. Also, if the Gator Pond area is protected in the process of recovering Bakersfield smallscale and Buena Vista Lake shrew, Comanche Point layia potentially could be reintroduced. The status of Comanche Point layia should be reevaluated within 5 years of recovery plan approval or when surveys have been completed, whichever is less.

9. Munz's Tidy-tips (Lavia munzii)

Taxonomy.—Keck (1935) named Munz's tidy-tips (*Layia munzii*) in the same publication in which he described Comanche Point layia. The type locality for Munz's tidy-tips is "32 miles (51 kilometers) east of Paso Robles" in San Luis Obispo County (Keck 1935, p. 17). The scientific name has not changed (Baldwin and Bainbridge 1993).

Description.—Munz's tidy-tips (Figure 28) is closely related to Comanche Point layia but the two species differ in appearance. The stems of Munz's tidy-tips may trail along the ground or grow upright, the leaves are not fleshy, and the ray florets are yellow with white tips. Munz's tidy-tips closely resembles the common tidy-tips (*L. platyglossa*) and the rare Jones' tidy-tips (*L. jonesii*). These three species are distinguished by subtle characteristics of the flower heads and achenes. Also, Jones' tidy-tips has purple streaks on the stem, unlike Munz's tidy-tips (Munz and Keck 1959, Abrams and Ferris 1960, Hoover 1970, Baldwin and Bainbridge 1993).

Historical Distribution.—Historically, Munz's tidytips was widespread in the western San Joaquin Valley and inner Coast Ranges from Fresno south (Figure 29). In Fresno County, the species was collected near Firebaugh, Little Panoche Creek, Mendota, the town of



Figure 28. Illustration of Munz's tidy tips (from Abrams and Ferris 1960, with permission).

San Joaquin, and Wheatville. In San Luis Obispo County, Munz's tidy-tips occurred from the Cholame Valley (where the type specimen was collected) to the Carrizo Plain (Hoover 1937, 1970, Twisselmann 1956, CDFG 1995). The species was described as occasional in Kern County (Twisselmann 1967), but the only specific locations reported were west of Wasco and near Elmo (CDFG 1995). According to Abrams and Ferris (1960), Munz's tidy-tips also occurred in Merced County.

Current Distribution.—Few of the historical populations of this species have been confirmed in the past 50 years. However, Munz's tidy-tips most likely still occurs near Soda Lake and was observed in the vicinity of Lost Hills during the late 1980s. The two occurrences reported from Kern County have been eliminated (CDFG 1995).

Life History and Habitat.—Munz's tidy-tips is an annual that flowers during March and April. Crosspollination is required for seed set (Munz and Keck 1959). Other facets of the life history have not been studied. Munz's tidy-tips grows on alkaline clay in low-lying areas and on hillsides in grasslands, Valley Saltbush Scrub, and Valley Sink Scrub. Associated species may include red brome, annual fescue, Lost Hills saltbush, common tidy-tips, iodine bush, and spiny saltbush (Hoover 1937, Munz and Keck 1959, Twisselmann 1967, Hoover 1970, Skinner and Pavlik 1994, CDFG 1995). Historical sites ranged from 45 to 800 meters (150 to 2,600 feet) in elevation (CDFG 1995).

Reasons for Decline.—Both Kern County occurrences of Munz's tidy-tips were destroyed by conversion to agriculture. Many low-lying areas in Fresno, Kern, and San Luis Obispo Counties have been cultivated, which may have destroyed other populations.

Threats to Survival.—The recently-observed site near Lost Hills is on an airport runway and therefore is subject to continued disturbance. If other Valley-floor sites remain extant, they could be threatened by agricultural conversion and commercial development.

Conservation Efforts.—The Carrizo Plain metapopulation of Munz's tidy-tips is in the proposed Carrizo Area of Critical Environmental Concern on the Carrizo Plain Natural Area (USBLM in litt. 1993). This species may occur in reserves on the San Joaquin Valley floor, such as Center for Natural Lands Management's Semitropic Ridge, but its presence remains to be verified.

Conservation Strategy.—To ensure long-term conservation of Munz's tidy-tips, the strategy is to protect at least 5 populations representing the full historic range of the species. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. The presence of this species on public lands does not negate the need for protection elsewhere. Protection from development and incompatible uses is equally important on both public and private lands. Surveys are necessary to determine the current status of historical populations as well as threats facing each occurrence (Skinner and Pavlik 1994). populations should be protected from any site-specific threats and monitored regularly. Munz's tidy-tips could benefit from survey and protection efforts for listed species, including palmate-bracted bird's-beak, Fresno kangaroo rat, and Tipton kangaroo rat, and for species of concern such as Lost Hills saltbush and Jared's peppergrass. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Munz's tidy-tips should be reevaluated.

10. Jared's Peppergrass (Lepidium jaredii)

Taxonomy.—Lepidium jaredii was named by Brandegee (1894). Jared collected the type specimen "near Goodwin, San Luis Obispo County" (Brandegee 1894, p. 398). Hoover (1966) divided the species into two subspecies: Panoche peppergrass (L. jaredii ssp. album) and Carrizo peppergrass (L. jaredii ssp. jaredii). The type locality for Panoche peppergrass is "Arroyo Hondo wash north of Cantua Creek, Fresno County" (Hoover 1966, p. 345). The type locality for Carrizo peppergrass is by definition the same as that for the entire species. Although the most recent treatment of the genus (Rollins 1993) did not differentiate between the subspecies, California Native Plant Society (Skinner and Pavlik 1994) follows Hoover's taxonomy. Jared's peppergrass is in the mustard family.

Description.—Jared's peppergrass (Figure 30) varies from 10 to 70 centimeters (4 to 28 inches) in height, and the stems may be branched. It has narrow leaves, which occasionally have a few teeth on the margins. Each plant has many tiny flowers, which are distributed along the upper portions of each branch. The

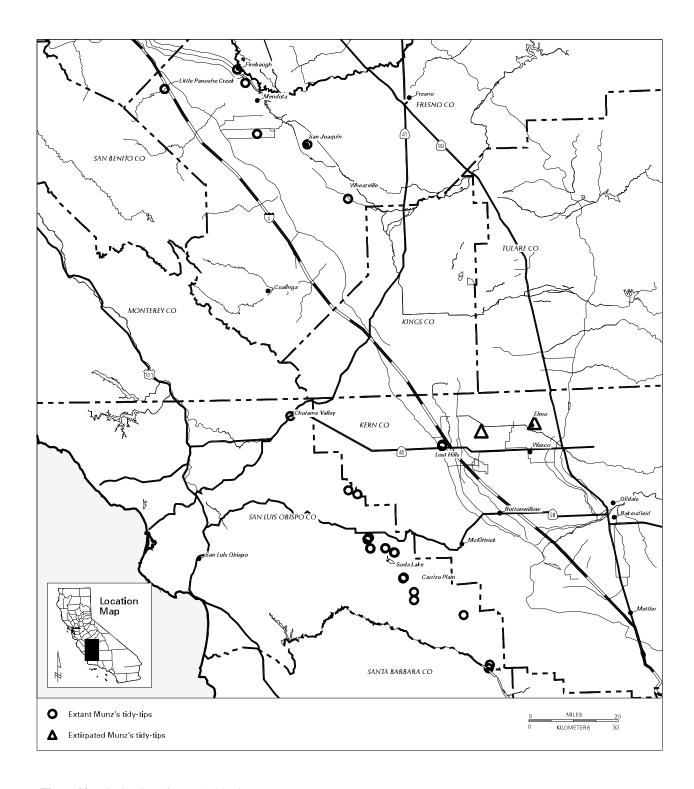


Figure 29. Distribution of Munz's tidy-tips (Layia munzii).

flattened, egg-shaped fruits contain two seeds each (Munz and Keck 1959, Rollins 1993). Panoche peppergrass has white flowers and numerous branches, whereas Carrizo peppergrass has yellow flowers and few branches (Hoover 1937, 1966, Taylor et al. in litt. 1990).

Historical Distribution.—Jared's peppergrass ranged from San Benito County south to San Luis Obispo County, with Panoche peppergrass occupying the northern portion of the species' range (Figure 31). Locations mentioned in the literature prior to 1966 can be assigned to a subspecies only tentatively. Apparently, collections from Arroyo Hondo, Little Panoche Creek, Panoche Creek, Riverdale, south of Mendota, and 20 miles northeast of Corcoran (all in Fresno County), and between Panoche and Idria in San Benito County represent Panoche peppergrass (Hoover 1966, CDFG 1995, Taylor et al. in litt. 1990). Carrizo peppergrass was reported historically from the Carrizo Plain (including the type locality) and Estrella in San Luis Obispo County (Brandegee 1894, Hitchcock 1936, Twisselmann 1956, Hoover 1970).

Current Distribution.—Currently, Panoche peppergrass is known or presumed to be extant at approximately 15 occurrences. The majority of the sites, including Arroyo Hondo and Panoche Creek, are in the Ciervo-Panoche region of Fresno and San Benito Counties (CDFG 1995, Taylor et al. in litt. 1990, Beehler

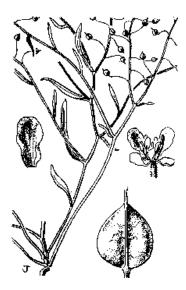


Figure 30. Illustration of Jared's peppergrass (from Abrams 1944, with permission).

in litt. 1994). One or two sites may remain in southern Fresno County and another in the Orchard Peak area of San Luis Obispo County (Skinner and Pavlik 1994). Carrizo peppergrass is extant at several occurrences south of Soda Lake on the Carrizo Plain, which comprise a single metapopulation. Two other occurrences of Carrizo peppergrass have been discovered recently: Padrones Canyon in the eastern foothills of the Caliente Mountains in San Luis Obispo County, and the Devil's Den area in Kern County (CDFG 1995, Taylor et al. in litt. 1990).

Life History and Habitat.—Both subspecies of Jared's peppergrass are annuals. Panoche peppergrass flowers from February to June and Carrizo peppergrass from March to May (Skinner and Pavlik 1994), but few plants bloom in dry years (Hoover 1937). Both taxa can grow in heavy clay or sandy soils. Panoche peppergrass occurs in dry stream beds, on alluvial fans, and on slopes. Associated species include a variety of grasses and forbs as well as the shrubs common saltbush, quailbush (Atriplex lentiformis), mulefat (Baccharis salicifolia), and scale-broom (Lepidospartum squamatum). Carrizo peppergrass occurs in association with spiny saltbush, Munz's tidy-tips, and Lost Hills saltbush in the lowlying, alkaline areas south of Soda Lake. In Padrones Canyon, Carrizo peppergrass occurs with hillside daisy (Monolopia lanceolata) on steep, south-facing slopes. Both subspecies occur at sites below 1,000 meters (3,300 feet) in elevation (Hoover 1970, CDFG 1995, Taylor et al. in litt. 1990, Lewis in litt. 1994a, Beehler in litt. 1994).

Reasons for Decline and Threats to Survival.—Panoche peppergrass populations have been subject to disturbance from sand and gravel quarrying. Trampling by cattle is a possible threat to populations of this subspecies. Carrizo peppergrass does not seem to have declined, and the only reported site-specific threat is sheep grazing at Devil's Den (Skinner and Pavlik 1994, CDFG 1995, Taylor et al. in litt. 1990, Beehler in litt. 1994).

Conservation Efforts.—In 1988, Dean Taylor of BioSystems Analysis, Inc., and biologists from the Hollister Resource Area of USBLM began surveys for Panoche peppergrass in both historical locations and suitable habitats. After they discovered the Fresno and San Benito county populations, USBLM acquired several of the sites that were on private land and now protects them from mining. The Orchard Peak, Carrizo Plain, and Padrones Canyon areas are under the

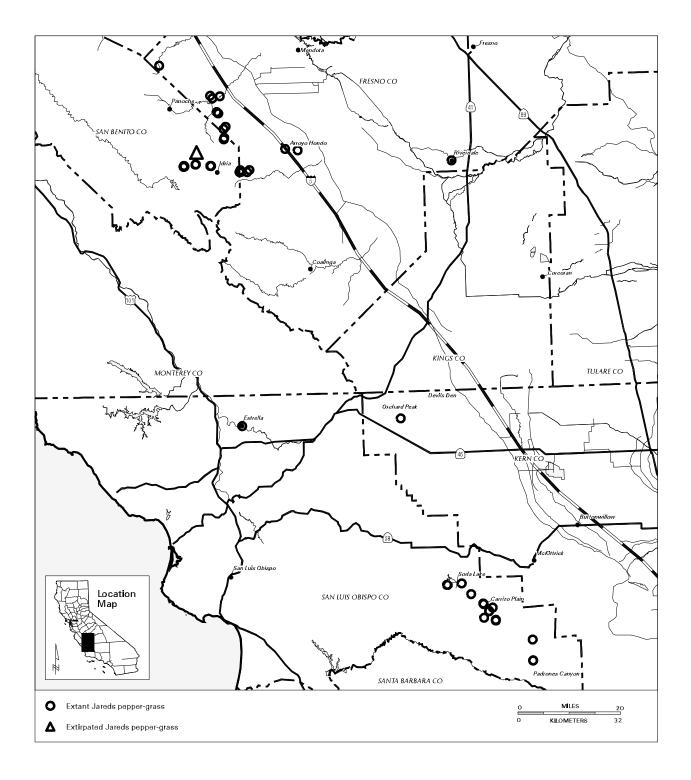


Figure 31. Distribution of Jared's peppergrass (Lepidium jaredii).

administration of USBLM and are either existing or proposed Areas of Critical Environmental Concern (CDFG 1995, Taylor et al. in litt. 1990, USBLM in litt. 1993, Lewis in litt. 1994*a*, Beehler in litt. 1994, D. Taylor pers. comm.).

Conservation Strategy.—To ensure the long-term conservation of Jared's peppergrass, the strategy is to protect at least 5 distinct populations of each subspecies, representing the full geographic range of the species. However, the more populations, the greater the likelihood of long-term survival for the species. Therefore, as many populations as possible should be protected, even though more than five currently are known from public lands. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Protection from development and incompatible uses is equally important on both public and private lands. The most important task to ensure the survival of Jared's peppergrass is to exclude severe surface-disturbing activities such as mining and land conversion within occupied areas. Light grazing may continue where impacts have not been observed. However, population monitoring is necessary; if declining population trends are noted, management changes may be necessary. Field inventories for both subspecies also should be continued, particularly in wet years, to verify the status of historical populations and arrange for their protection. When surveys have been completed or at a maximum within 10 years of recovery plan approval, the status of Jared's peppergrass should be reevaluated.

11. Merced Monardella (Monardella leucocephala)

Taxonomy.—Merced monardella is known today by the scientific name published by Gray (1867), Monardella leucocephala. The type specimen was collected in Merced County on the plains near the Merced River (Epling 1925). Greene transferred Merced monardella to the genus Madronella in 1906, but Epling (1925) returned the species to Monardella. The scientific name has not been altered since (Jokerst 1993, Stebbins in litt. 1993). Merced monardella is a member of the mint family (Lamiaceae).

Description.—Merced monardella (Figure 32) has square stems 15 to 20 centimeters (6 to 8 inches) tall. Both the stems and the opposite, lance-shaped leaves are gray-hairy and have a characteristic mint scent. Although the white flowers are tiny, the flower heads are showy because each one is surrounded by a circle of white bracts. Merced monardella can be distinguished from the related species Sierra monardella (*M. candicans*) and coyote-mint (*M. villosa*) by the color of the stems, bracts, and flowers; microscopic differences in the flowers; and habitat (Munz and Keck 1959, Jokerst 1993).

Historical and Current Distribution.—Historically, Merced monardella was collected from five individual sites that were clustered in two areas: (1) near the Merced River south of Delhi in Merced County (including the type locality); and (2) along the Tuolumne River near La Grange and Waterford in Stanislaus County (Figure 33). The most recent record of the species was from 1941 (Skinner and Pavlik 1994, CDFG 1995, Stebbins in litt. 1993). Merced monardella was not found at historical sites during recent surveys but may persist on private lands where access was denied (Stebbins in litt. 1993).

Life History and Habitat.—This annual plant may grow only in years of above-average precipitation; it flowers in May, June, and July after the soil dries. Merced monardella is restricted to extremely sandy,

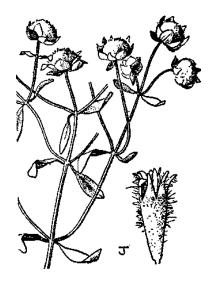


Figure 32. Illustration of Merced monardella (from Abrams 1951, with permission).

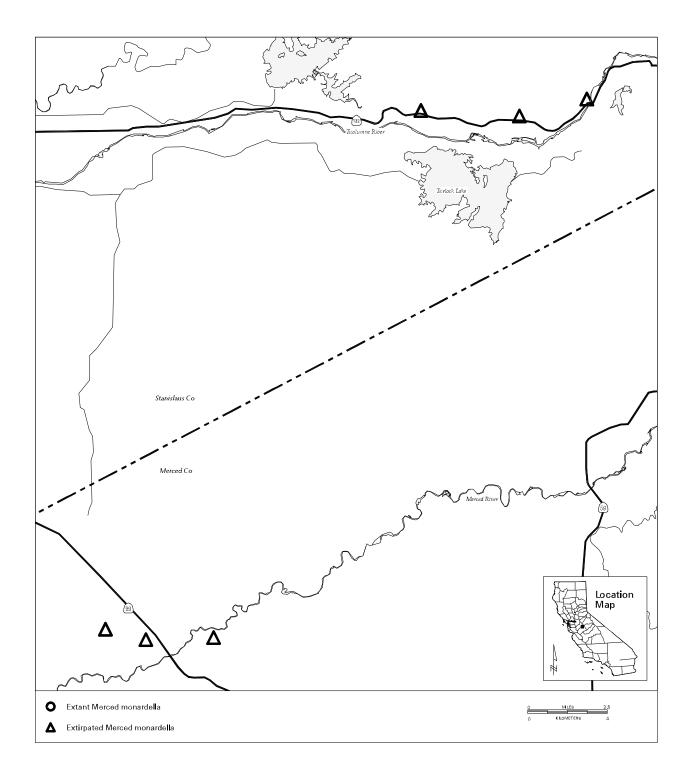


Figure 33. Distribution of Merced monardella (Monardella leucocephala).

subalkaline soils in low-lying areas bordering rivers. The native vegetation in these areas is grassland, but several collections were made in dry-farmed fields. The only associated species mentioned by collectors was naked buckwheat (*Eriogonum nudum*). Elevations at the historical sites range from approximately 15 to 80 meters (50 to 260 feet) (Hoover 1937, CDFG 1995, California Native Plant Society in litt. 1988b, Stebbins in litt. 1993).

Reasons for Decline and Threats to Survival.— Much of the suitable habitat for Merced monardella was converted to agriculture more than 50 years ago (Hoover 1937). The intensive, irrigated agriculture practiced today is incompatible with survival of this species, unlike the dry-land grain farming common in the past. Other activities that may have contributed to its decline include urban development and sand and gold extraction. The remaining suitable habitats that may support undiscovered populations are primarily in private ownership and thus are subject to these same threats (CDFG 1995, California Native Plant Society in litt. 1988b, Stebbins in litt. 1993).

Conservation Efforts.—USFWS recently sponsored a status survey for Merced monardella, which included field surveys from 1990 through 1992. California Native Plant Society has stressed the importance of conducting surveys for Merced monardella, although this species has been listed as "presumed extinct" pending rediscovery (Skinner and Pavlik 1994, Skinner et al. 1995).

Conservation Strategy.—To ensure long-term conservation of Merced monardella, the strategy is to protect at least five distinct populations. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. Surveys for Merced monardella must be continued in both historical sites and suitable habitats, especially in years of above-average precipitation. The cooperation of private landowners is a prerequisite for surveys at some sites, and therefore an incentive program should be devised. If any populations are found, site-specific threats must be determined and Monitoring should be initiated in all negated. populations if the species is rediscovered. The status of Merced monardella should be reevaluated within 5 years of recovery plan approval or when surveys have been completed, whichever is less.

12. Merced Phacelia (Phacelia ciliata var. opaca)

Taxonomy.—Howell (1936) published the name *Phacelia ciliata* var. opaca for Merced phacelia. He cited the type locality as "clay hills 5 miles northeast of Merced, Merced Co." (Howell 1936, p. 221). Authors of subsequent floras (Abrams 1951, Munz and Keck 1959, Wilken et al. 1993) considered Merced phacelia to be merely a minor variant of the Chinese-lantern phacelia (*P. ciliata*) that did not warrant formal taxonomic recognition. Nonetheless, California Native Plant Society (Skinner and Pavlik 1994) continues to treat Merced phacelia as a distinct variety. This taxon is a member of the waterleaf family (Hydrophyllaceae).

Description.—Merced phacelia (Figure 34) reaches a maximum height of 55 centimeters (22 inches). The leaves vary in both size and shape, ranging from 3 to 15 centimeters (1 to 6 inches) long and from deeply-lobed to divided. Each branch tip is coiled like a scorpion's tail and holds many flowers. The individual flowers are approximately 1 centimeter (0.5 inch) long, bell-shaped, and blue with pale centers. The *calyx*, which is the group of leaf-like structures below the petals, has five *ciliate* (with stiff hairs along the margin) *lobes* (free tips of parts that are fused at the base). The calyx is inconspicuous while the flowers are open; as the fruits mature, the calyx lobes elongate and become opaque (hence variety *opaca*). Conversely, in Chinese-lantern phacelia the

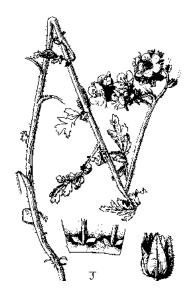


Figure 34. Illustration of Merced phacelia (from Abrams 1951, with permission).

calyx lobes grow broader and remain translucent at maturity (Wilken et al. 1993, Constance in litt. 1979).

Historical and Current Distribution.—Merced phacelia was collected in east-central Merced County near the towns of Le Grand, Merced, Planada, and Tuttle between 1929 and 1939 (Figure 35). A very small population, consisting of fewer than 10 individuals, was observed in 1977 approximately 10 km (6 miles) northeast of Merced. The other historical locations have not been visited for over 50 years due to a lack of access (Howell 1936, Skinner and Pavlik 1994, CDFG 1995, Constance in litt. 1979).

Life History and Habitat.—This annual plant flowers between February and May. Merced phacelia is restricted to heavy clay soils on the Valley floor and adjacent low hills at elevations below 100 meters (328 feet). Other aspects of its life history and habitat have not been reported (Howell 1936, Hoover 1937, Skinner and Pavlik 1994, Constance in litt. 1979).

Reasons for Decline and Threats to Survival.—
Merced phacelia is rare by virtue of its restricted range.
Most historic populations are inaccessible, therefore, no estimate can be given of the species relative abundance.
The historical sites do not face any known threats at this time, though development of the planned University of California campus east of Merced and the consequent induced growth should be considered a significant threat.

Conservation Efforts.—No conservation measures have been instituted for Merced phacelia.

Conservation Strategy.—Cooperation of property owners will be key to protecting this taxon. To prevent the need for listing Merced phacelia, the strategy is to protect at least 5 distinct populations. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes. The first step will be for qualified botanists to obtain permission to survey historical locations to determine the current status of populations. Prospects for the persistence of Merced phacelia will be favorable if the majority of the populations remain extant and are free from threats. The second step, should any occupied habitats are found to face major threats, will be to pursue conservation easements, and identify and address site-specific management needs. Research into the taxonomy and genetics of the Phacelia ciliata complex could determine

whether this taxon deserves recognition (Skinner et al. 1995), but it is a low-priority task. When surveys have been completed, or at a maximum within 10 years of recovery plan approval, the status of Merced phacelia should be reevaluated.

13. Oil Neststraw (Stylocline citroleum)

Taxonomy.—Oil neststraw was recently recognized as a distinct species, Stylocline citroleum (Morefield 1992), even though herbarium specimens were collected as early as 1883. Munz collected the type specimen in 1935 from flats near Taft, in Kern County (Morefield 1992). Oil neststraw is believed to have originated as a hybrid of two common species, everlasting neststraw (Stylocline gnaphaloides) and California filago (Filago californica). However, oil neststraw satisfies the definition of a species because it is capable of reproducing itself without further crossing of the parental species (Morefield 1992). Oil neststraw is a member of the aster family.

Description.—Oil neststraw is inconspicuous because it grows low to the ground and does not have showy flowers. It has trailing, woolly stems less than 13 centimeters (5 inches) long and small, woolly leaves. The round flower heads are 5 millimeters (0.2 inch) or less in diameter. Each flower head contains many individual florets, which consist of reproductive parts and papery scales covered with woolly hairs. The fruits are tiny, brown achenes. Oil neststraw is difficult to distinguish from closely related species because the identifying characters are microscopic (Morefield 1992, 1993).

Historical Distribution.—Five populations of oil neststraw were known historically, based on collections made from 1883 to 1935 (Figure 36). Four of the occurrences were in Kern County, in the vicinities of Bakersfield, McKittrick, and Taft (two sites, including the type locality). The fifth collection was made in San Diego County.

Current Distribution.—Morefield (pers. comm.) was unable to rediscover oil neststraw at any of the historical locations. Although natural land remains at most sites, the location descriptions are vague. Four new occurrences were discovered between 1988 and 1995 on the Elk Hills Naval Petroleum Reserves in California in

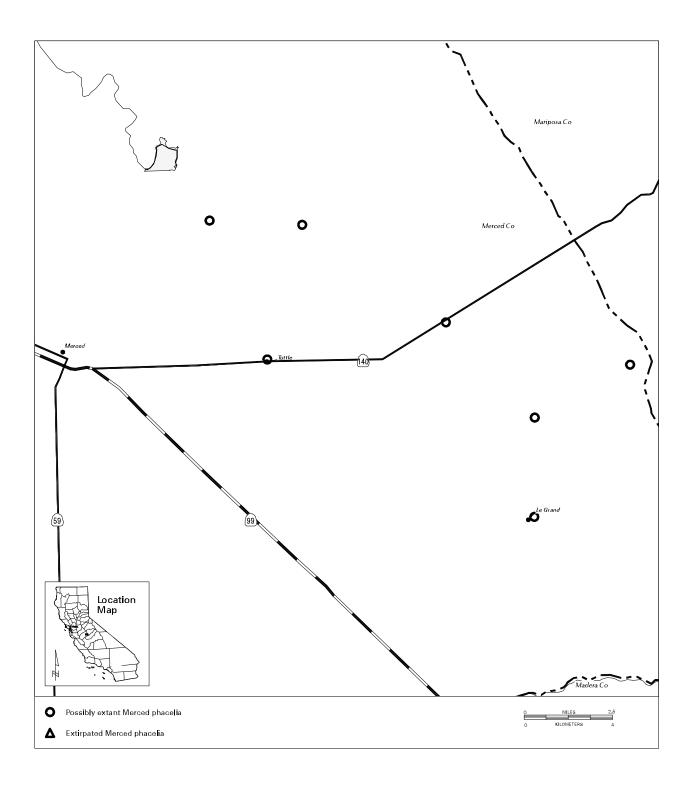


Figure 35. Distribution of Merced phacelia (Phacelia ciliata var. opaca).

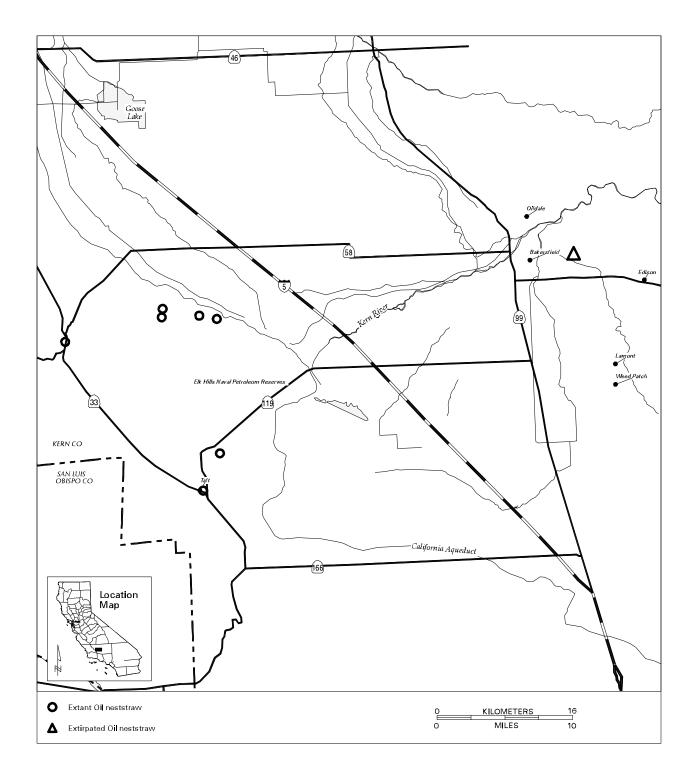


Figure 36. Distribution of oil neststraw (Stylocline citroleum)

Kern County (Figure 36) (J. Hinshaw pers. comm., D. Taylor pers. comm.).

Life History and Habitat.—Oil neststraw, an annual, flowers in April and reproduces strictly by selfpollination. The extant occurrences and several of the historical localities are in petroleum-producing areas, giving rise to both the common and scientific names. This species grows on flats and on slopes. One of the Elk Hills populations of oil neststraw occurs on the bank of a wash in a very sparsely vegetated area that has welldeveloped cryptogamic crust. The few plant species associated with oil neststraw at that site are natives such as everlasting neststraw, California filago, Hoover's woolly-star, and many-flowered eriastrum. Plant species that occur with oil neststraw in the other Elk Hills sites are red brome, common saltbush, and white burrobush (Hymenoclea salsola). All the extant occurrences are in the Valley Saltbush Scrub plant community in undeveloped areas. Oil neststraw has been found at elevations of 60 to 320 meters (200 to 1,050 feet) on both sandy and clay soils (Morefield 1992, EG&G Energy Measurements unpublished data, D. Taylor pers. comm.).

Reasons for Decline and Threats to Survival.— Urban development has almost certainly eliminated the historical populations of oil neststraw in the vicinities of San Diego and Bakersfield, and possibly the one near Taft (Skinner and Pavlik 1994). Petroleum production is the primary use in the other areas where oil neststraw occurred historically, but actual population losses to oilfield activities have not been documented. The known populations on Elk Hills are not in an area with high potential for oil extraction (B.L. Cypher pers. comm.). However, any surface-disturbing activities would be detrimental to oil neststraw (J. Morefield pers. comm.).

Conservation Efforts.—All conservation efforts to date for oil neststraw have been accomplished by U.S. Department of Energy and their contractors in the Endangered Species and Cultural Resources Program at Elk Hills. U.S. Department of Energy funded limited surveys for oil neststraw at the Naval Petroleum Reserves in 1995, resulting in the discovery of three new occurrences in addition to the one discovered by Taylor in 1988. Morefield verified the identity of the specimens from Elk Hills. Comprehensive floristic surveys of Naval Petroleum Reserve-1 in California will begin in 1996; oil neststraw is one of the rare plant species to be targeted during the surveys. Jay Hinshaw has developed a field key to oil neststraw and related species to facilitate

identification and to permit mapping of occurrences, and he has conducted workshops to train local biologists in recognizing the species (J. Hinshaw pers. comm.). U.S. Department of Energy has entered into a voluntary agreement with USFWS to protect the 4 known populations on Elk Hills. One or more of these occurrences are likely to be included in the conservation area that U.S. Department of Energy will set aside within the next 3 years (B.L. Cypher pers. comm.).

Conservation Strategy.—The strategy for oil neststraw is similar to that for other species of concern: to protect at least five distinct populations representing the full geographic range of the species in the San Joaquin Valley. The four known occurrences at Elk Hills represent a single metapopulation; all four occurrences should be protected and collectively constitute one of the five required populations. Protected areas should be natural land in blocks of at least 65 hectares (160 acres) and should contain a minimum of 1,000 individuals to reduce the likelihood of extinction from intrinsic or random processes.

Several tasks are necessary to prevent the extinction of oil neststraw. First, the local populations at Elk Hills must be protected from disturbance (deliberate or accidental) for the foreseeable future. Although U.S. Department of Energy has agreed to protect the Elk Hills occurrences from disturbance as long as they are responsible for operation of the area, Congress has authorized the sale of Naval Petroleum Reserve-1 in California to private industry by 1998 (B. L. Cypher pers. comm.). Therefore, conservation agreements must be negotiated with the new owners. Next, intensive surveys should be undertaken in suitable habitats throughout the southern San Joaquin Valley. The species has been overlooked in the past because it is so small, because it grows intermixed with superficially similar plants, and because it was not recognized as a species until 1992. However, the availability of keys based on both field and microscopic characters and Morefield's willingness to identify questionable specimens should overcome most limitations to species identification. The nature and magnitude of threats should be determined for all populations that are discovered, and steps should be taken to prevent habitat loss or degradation. In addition, site factors should be characterized to provide clues to the species' habitat requirements. All extant populations should be monitored annually to evaluate population trends. The status of oil neststraw should be reevaluated within 5 years of recovery plan approval.